UTS UNIVERSITY OF TECHNOLOGY SYDNEY

Secondary student conceptualisations of subjects facing a survival dilemma: The relationship between student conceptualisation, motivation, and value proposition in the case of technology and languages.

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Thesis submitted in fulfilment of the requirements for the degree of

Doctor of Philosophy in International Studies

under the supervision of

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February 2025

CERTIFICATE OF ORIGINAL AUTHORSHIP

I, Colin Klupiec, declare that this thesis, is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the School of International Studies and Education, Faculty of Arts and Social Sciences at the University of Technology Sydney.

This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

This document has not been submitted for qualifications at any other academic institution.

This research is supported by the Australian Government Research Training Program.

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Date: 30 April 2024

Acknowledgements

These acknowledgements are written with sincere gratitude to the people without whom this thesis would not have been possible.

The participants of the study. I am truly grateful for their contributions in both visual and verbal responses to the research questions. In schooling environments where they are already heavily tested, evaluated, and ranked, they offered their time to opt in, providing conscientious and wonderfully creative artefacts. Each of their efforts is highly commendable.

Professor Lesley Harbon, Principal Supervisor of this thesis. Upon reflection, I am continually astounded by Lesley's immensely influential, yet delightfully gentle support. Through thoughtful, timely, and highly constructive feedback, Lesley has made a profound impact on my research skills, writing and communicative style. I will be forever grateful.

Professor Nick Hopwood. The experience of being in Nick's classes in the early stages of this thesis was foundational to its completion. The dynamic learning environment Nick facilitated enabled me to explore ways to improve my writing and critical thinking in ways I had not thought possible.

Dr Joanne Yoo and Dr Pauline Kohlhoff. Two colleagues who offered continual encouragement and support throughout the completion of this research. Joanne and Pauline helped me to stay positive regardless of the circumstances.

Dr Mark Tutton, Co-Supervisor of this thesis. Mark accepted the invitation to co-supervise part way through this thesis. Mark offered insightful and constructive feedback which helped to make significant contributions to my writing.

Mr David Mason. A long-time friend and colleague who made regular contact to encourage, support, and provide accountability for my progress throughout this thesis. David played a pivotal role in keeping me focussed and motivated.

My wife Hannah, and my son Noah. Over the years of completing this thesis, Hannah and Noah have offered unwavering support for this immense project. It is difficult to quantify how significant their contribution has been. I am truly blessed to have had their companionship throughout these challenging years.

The thesis received editorial input from Dr Terry Royce, a Professional Member of the Institute of Professional Editors (IPEd.)

Statement of Format of Thesis

This thesis follows a conventional format.

- An introduction to the research study and a justification of how it adds to knowledge in the field.
- A review of the literature.
- A description and justification for the research approach and methods.
- A presentation of results.
- A discussion and conclusion.

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ABSTRACT

Secondary student conceptualisations of subjects facing a survival dilemma: The relationship between conceptualisation, motivation, and value proposition in the case of technology and languages.

Technology and languages education in Australia face a crisis of participation and performance. Calls for greater participation in technology subjects exist alongside a recognition of a greater need for foreign language learning. There is a dilemma to resource schools in subject areas of perceived need yet lower enrolments. Investigation in this study is based on student conceptualisations of technology and languages subjects produced in participant-drawn concept maps and interviews. Qualitative content analysis revealed the nature of student conceptualisation and the extent that value perception played in student motivation and subject selection. This thesis reports on the application of the conceptual frame of 'disruptive innovation' to understand value perceptions held by students in the case of technology and languages. Findings inform schools on how the application of specific strategies to the dilemma embedded in a disruptive frame may be applied by school decision-makers to (1) better equip schools in subject resource allocation, and (2) enable students to better identify value in subjects they select. For technology and languages teachers, approaches are presented for enhancing student participation and better aligning subject delivery with student expectations.

Chapter 1: Introduction

This study about the value propositions found in secondary technology and languages subjects took place in three different secondary school contexts in New South Wales (NSW) and the Australian Capital Territory (ACT). The study focussed on how students conceptualise these subjects and what value propositions motivated the students to select them. The two broad subject categories of technology and languages are seemingly disparate. Yet their identification for investigation is pertinent for new insight into student subject selection given the rationale for Australian education. The Australian Curriculum Assessment and Reporting Authority states a heightened "need to nurture an appreciation of, and respect for, social, cultural and religious diversity, and a sense of global citizenship", and to develop students who "are able to relate to and communicate across cultures" (ACARA, 2011, p. 6). Languages play a key role in this diversity, as does technology as an enabler in the global context. The emerging curriculum of STEM (science, technology, engineering, and mathematics) is included in the technology category. Due to the attention it receives as a subject area of future importance, STEM is discussed and considered in the greater context of science and technology as a developing social construct. A qualitative approach is used to understand how students and teachers conceptualise their subjects, and how value propositions within those subjects influenced student choice in electing to study those subjects. The study also seeks to examine the extent to which complementary value propositions exist between technology and languages subjects, and whether they could influence subject selection.

The Australian Curriculum (AC) provides a broad scope for the study of technology under the umbrella of its two main subjects:

- Design and Technologies
- Digital Technologies

(ACARA, 2024d)

In this context, it is also reported that STEM participation and performance exhibit notable decline in Australian secondary education (Education Council, 2018; Office of the Chief Scientist, 2017). Local and international bodies cite an increased need for STEM participation to meet global challenges for survival (ACARA, 2024a; National Research Council, 2011) but also for STEM programs that are socially, culturally and globally relevant (Office of the Chief Scientist, 2013). Against this backdrop, Australian education bodies also note that foreign language learning is in decline (Marginson et al., 2013) at a time when intercultural capability, the ability to "negotiate experiences and meanings across languages and cultures" and a proficiency "in English only is no longer sufficient" (ACARA, 2024c, para. 3). Students continue to select these subject areas for senior secondary study despite the decline, yet there is a dearth of research that investigates the intersection of these two disciplines with a view to exploring opportunities for new value.

The study is placed in the context of curriculum reform and innovation. Statements made by education, scientific and political bodies have set clear agendas for the development of technology and STEM curricula which are essentially new, with a vision for addressing global needs. The Australian Curriculum, for example, presents this mandate.

> All young Australians should develop capacity for action and a critical appreciation of the processes through which technologies are developed and how technologies can contribute to societies. Students need opportunities to consider the use and impact of technological solutions on equity, ethics, and personal and social values.
> (ACARA, 2024d, Rationale, para. 4)

The notions of 'new', 'develop capacity for action' and 'opportunity' imply innovation, but the nature of the innovation is unclear. At the same time, a dilemma emerges; the dissonance between calls for greater participation and performance in technology (and STEM), the recognition of greater need for additional language learning, and decisions at the school level to allocate resources to subjects of high global need but low student participation.

A Framework for Innovation

To develop a deeper understanding of how students identify value in the seemingly disparate subject areas of technology and languages, the frame of 'disruptive innovation' is considered (Christensen, 2013). An analogy comes from the commercial business context, whereby disruptive innovation describes how successful firms can fail when "decisions that led to failure were made when the leaders [companies] in question were widely regarded as among the best companies in the world" (Christensen, 2013). These decisions were broadly focussed on satisfying mainstream customer demand at the expense of recognising industry change caused by the influence of 'fringe customers'. Failure of leaders occurred when 'new entrant' firms catered to the value propositions favoured by fringe customers, allowing them to gain a foothold in the market and undermine incumbent firms.

In the study being reported on in this thesis, a parallel is drawn between firms and education with respect to the abovementioned dilemma. Failure in the education context is seen as the low participation and performance in recognised areas of need caused by the focus on resource allocation to subjects of higher enrolment, or mainstream subjects (Marginson et al., 2013). Less considered value propositions are those identified by the relatively small number of technology and language students. Those students are what Christensen (2013) describes as fringe customers, who see value where the mainstream does not. This thesis uses student conceptualisation to identify how students perceive present and future value in their subjects and how that value influences motivation to select the subject. In addition, the study considers

the potential complementary value propositions found in technology and languages subjects, and how they may influence students to select previously unconsidered subjects. A student's perception of the value proposition offered by the subject selected therefore becomes a key consideration of this study.

The broad nature of 'technology' also requires acknowledgement of the greater context in which current curricula have been developed. Therefore, the social factors that have influenced how society has held technology as a vehicle for societal and political change are also considered. Moreover, how imperatives for education have been driven through these changes. Coupled with these are factors such as marginalisation of cultural and gender groups which makes it difficult to separate technology from society. Innovation as an agent of change must also be considered in this context, as approaches vary from incremental improvement to radical, or breakthrough changes. Conceptualisations for 'technology' and its connection to other disciplines as an expression of innovation are shown to have a diverse history that long predates movements like STEM. As such, it becomes necessary to provide a brief overview of definitions for technology and STEM as a contemporary adaptation of an integrated, or innovative approach to technology.

The overview of technology/STEM that leads this introduction is followed by discussion which explores the rationale for Australian languages education in the context declared by ACARA. The discussion highlights that languages education has also been influenced heavily by social, political, and economic factors which have steered practice and perception within schools. An early indication proceeding from that discussion is the opportunity for further investigation into student perception and how perceived value can be better identified, understood, and leveraged. When considered together, the disparate nature of technology and languages subjects provides fertile ground for the frame of disruptive innovation to expose previously unknown or unconsidered value propositions. An understanding of what perceptions students hold, and the nature of their value can assist schools in addressing the dilemma stated above and offer new insight to students in subject selection.

1.1 Definitions of 'Technology'

As the world becomes more digitised and technology oriented, education commentary and research indicate an increased demand for technology-based curriculum. Included in this discussion are curricula generally referred to as STEM (science, technology, engineering and mathematics), although variations exist. Ritz and Fan (2015) suggest that despite mixed perceptions of what STEM actually is, little is being done to modify education systems to accommodate change. In the first instance, it therefore becomes useful to describe a broad

scope for STEM; for technology as described by the Australian Curriculum; and the wider concept of science and technology studies.

1.1.1 Perspectives on defining STEM

The STEM acronym delineates an area of study that could be defined simply in terms of its four component parts: science, technology, engineering and mathematics. However, this provides limited awareness of the scope or interconnectedness of those disciplines and how they might form a useful and cohesive endeavour. In the Australian context, the Office of the Chief Scientist provides a helpful framework in a 2013 Position Paper. It views STEM as an "enterprise" that operates "with a 'social licence' that is a part of its 'compact' with society" (Office of the Chief Scientist, 2013, p. 3). It suggests that the extent to which STEM can be effective will be determined by the depth of understanding of the societal context which is explored through the work of the social sciences and humanities (Office of the Chief Scientist, 2013). The scope also discusses society internationally, suggesting that "the STEM enterprise is truly global" and that it "bridges cultural divides through its absence of ideology and use of rational dialogue"(p. 22). This suggests intercultural interaction, although the notion that STEM is not influenced by ideology is subjective and difficult to conceive of if STEM exists in societal contexts. Moreover, these contexts are likely to shape how societies educate future STEM professionals, for as Ritz and Fan (2015, p. 446) note, "technology education does not mean the same thing to different people and different nations".

The Chief Scientist presents a scope similar to other Australian perspectives. The Education Council National STEM School Education Strategy states that,

> STEM education is a term used to refer collectively to the teaching of the disciplines within its umbrella – science, technology, engineering and mathematics – and also to a cross-disciplinary approach to teaching that increases student interest in STEM related fields and improves students' problem solving and critical analysis skills.
> (Education Council, 2015, p. 5)

This strategy description is brief and simplified to the four disciplines reflected in the STEM acronym. The strategy makes little or no reference, however, to conceptual linkages between the disciplines, or why they should be linked. It stops short of suggesting that a cross-disciplinary approach could include non-STEM disciplines, however it supports this concept by stating that, "STEM sits within a broader foundational knowledge base and the teaching of STEM is a part, albeit important, of a balanced program of learning" (Education Council, 2015, p. 5).

The United States National Research Council (NRC) describes the STEM disciplines as having broad impacts. It states;

> Science, mathematics, engineering, and technology are cultural achievements that reflect people's humanity, power the economy, and constitute fundamental aspects of our lives as citizens, workers, consumers, and parents.
> (National Research Council, 2011, p. 3)

Notably this description includes parents, but not children or students. The notion that the STEM disciplines are cultural achievements that reflect people's humanity potentially raises subjective questions as to how the STEM disciplines are used and how those reflections might be received by other cultures. Since STEM disciplines have been considered as cultural achievements, it becomes relevant to ask how these cultures will interact and communicate when impacts and/or intersections occur at an inter-country or intercontinental level. The authors make no specific reference to these questions, however they do stress the need to "increase the participation of groups that are underrepresented in the sciences, especially blacks, Hispanics, and low-income students who 'disproportionately fall out of the high achieving group in K-12 education'", and that "the changing demographics in the United States will require increased participation by domestic non-white and non-Asian students in STEM" (National Research Council, 2011, p. 4). This position may surmise an awareness of intra-cultural impacts as the authors are describing conditions within the USA. In addition, the NRC considers the need for STEM knowledge to be universal, stating that "an increasing number of jobs at all levels – not just for professional scientists – require knowledge of STEM", and that "individual and societal decisions increasingly require some understanding of STEM, from comprehending medical diagnoses to evaluating competing claims about the environment to managing daily activities with a wide variety of computer based applications" (National Research Council, 2011, p. 3).

Other descriptions, or definitions of STEM range widely. Bybee (2010, p. 30) notes that "STEM had its origins in the 1990s", and that it "has been used as a generic label for any event, policy, program, or practice that involves one or several of the STEM disciplines". Broad perspectives are offered including the need to,

- advance beyond a slogan;
- increase emphasis on technology, and not just mathematics and science;
- develop problem solving and 21st Century skills;
- increase innovation;
- develop integrated curriculums.

(Bybee, 2010)

Baillie and Metzger (2013) suggest that agreement on definitions is essential for making STEM education effective, stating that it must include,

- inquiry-based science and math education;
- integrated curriculum;
- project-based group learning;
- career awareness.

With respect to mathematics teaching, Baker and Galanti (2017) make strong references to the "traditionally siloed nature of mathematics instruction" (p. 2), and call for connectedness and integration with other subject disciplines. They cite Moore (2008) when describing that such an approach should "deepen student understanding of each integration discipline by contextualising concepts; [and] broaden student understanding of STEM disciplines through exposure to culturally relevant STEM contexts" in Baker and Galanti (2017, p. 3). Noteworthy in this approach is the repeated theme of integration, and the notion of cultural relevance.
A definition extending the concept of integration is offered by Basham et al. (2010, p. 11) which states that STEM education is an "interdisciplinary (or transdisciplinary) approach that integrates knowledge from diverse academic disciplines into authentic problem/project-based learning (PBL) experiences as related to instruction in STEM content areas." The authors do not specify what 'diverse' academic disciplines are, although it is inferred that they co-exist with STEM disciplines and that their content may intersect in authentic PBL experiences. What is considered to be an authentic experience may also be subject to debate, and thus definitions such as these may not assist in removing aforementioned ambiguity as regards STEM definitions.

In a study investigating elements of inclusive STEM high schools, Laforce et al. (2016) noted the lack of consensus about the meaning of STEM. The authors cite Merrill (2009) who provides a lengthy, but helpful definition, stated as

> a standards-based, meta-discipline residing at the school level where all teachers, especially science, technology, engineering, and mathematics (STEM) teachers, teach an integrated approach to teaching and learning, where discipline-specific content is not divided, but addressed and treated as one dynamic, fluid study.
> (Laforce et al., 2016, p. 10)

Noteworthy in this definition is that STEM is considered a meta-discipline, yet is standards based. Moreover, that there is a distinction between all teachers and STEM teachers (teachers of science, technology, engineering, and mathematics), but that both groups should teach with an integrated approach. This resonates with Basham et al. (2010) who refer to the integration of diverse academic disciplines. Again, other disciplines or curriculum learning areas are inferred to as intersecting with STEM, yet exactly how remains unclear. In addition to a lack of consistent definition, a consistent process for implementation appears absent. Laforce et al. (2016) also note that the definition has been extended in some cases to include the arts to form

the acronym ‘STEAM’. According to Ritz and Fan (2015, p. 446) the introduction of other subjects to be integrated with STEM comes from outside influences such as “political pressures, parent groups, government agencies [and] educational leaders”. As a result, in some contexts STEM has come to include “art, environmental science, design and graphic communication, and food and textiles” (p. 442). Still, others have even suggested STEMM, where the second ‘M’ could refer to multimedia (Cornelius, 2011), and even medicine. The inclusion of medicine would seem a natural conclusion given that the field of medicine is inherently scientific. Medicine also sits well with the Australian Chief Scientist’s position in that it falls within the description of an “enabling” discipline, such as biology and biomedical science (Office of the Chief Scientist, 2013, p. 4).

1.1.2 Technology in the Australian curriculum

As previously stated, technology in the Australian Curriculum is structured under two broad subject areas.

> Design and Technologies, in which students use design thinking and technologies to generate and produce design solutions for authentic needs and opportunities.
> Digital Technologies, in which students use computational thinking and information systems to define, design and implement digital solutions.
> (ACARA, 2024d, Introduction, p. 1)

Variation exists in how individual states within Australia address and implement the above subjects. For example, in New South Wales, the New South Wales Education Standards Authority (NESA) develops technology syllabi that reflect the requirements of the Australian Curriculum. Technology subjects of interest in this study are organised into the Technological and Applied Studies Learning Area which includes the following for years 9 and 10.

1. Agricultural Technology
2. Design and Technology
3. Food Technology
4. Graphics Technology
5. Industrial Technology
6. Information & Software Technology
7. Marine & Aquaculture Technology
8. Technology Mandatory
9. Textiles Technology

   (NESA, 2021)

NESA also enables schools the opportunity to offer a dedicated iSTEM Course (Education Standards Authority, 2023b). Whilst specific in title, it covers the specialised topics of,

- Advanced manufacturing
- Aeronautical engineering
- AgriTech
- Cyber security
- Design for space
- Mechatronics and robotics
- Med Tech
- Surveying and geospatial engineering
- Sustainable transport

(Department of Education, 2023, p. 10)

The Australian Curriculum Assessment and Reporting Authority (ACARA) does not define STEM as a learning area, although it suggests an integrated, or cross-discipline approach to science, technology, engineering and mathematics through its Technologies curriculum. Its overarching idea is the need to create "preferred futures", and states that,

> as students progress through the Technologies curriculum, they will begin to identify possible and probable futures, and their preferences for the future. They develop solutions to meet needs considering impacts on liveability, economic prosperity and environmental sustainability.
> (ACARA, 2024a, para. 2)

ACARA has also conducted research into STEM and provides resources to teachers for STEM implementation via findings from the STEM Connections project (ACARA, 2016).

For the purposes of the study in this thesis, and to create a practical sample set, the individual subjects described above are referred to as 'technology' subjects.

1.1.3 Science and technology as social constructs

The existence of STEM within a broader 'technology' curriculum context presents a conundrum. Science, Engineering and Mathematics are subjects explicitly defined in the Australian Curriculum. 'Technologies' (as opposed to technology) are broadly divided into 'design and technologies' and 'digital technologies', but this lacks the specificity afforded by the other three subjects. However, the combination of subjects has created an acronym that carries a large burden for ensuring economic and social prosperity (NSW Department of Education, 2020) despite a wide range of interpretations of what STEM is and means (Holmlund et al., 2018). As

previously stated, STEM is even considered to “operate with a social licence (Office of the Chief Scientist, 2013, p. 3) and that ‘technologies’ generally are forces that “shape the world in which we live” (ACARA, 2024d, Rationale, para. 2). This suggests that technology (or technologies), and the components of the STEM acronym are not separate from societies or cultures. Rather, that they are intertwined with them. Whilst the STEM acronym seems recent (appearing since roughly the 1990s), the connection of technology and the sciences has been debated for much longer, replete with the appropriate acronyms. A brief overview is provided.

Commentators point to the emerging American republic as an example of the impact of ‘technology’ as an influence in the creation of a society (Doel & Wang, 2002). During the Thomas Jefferson presidency, concerns ranged from exploration, scientific knowledge acquisition and the thrust of imperialism to more technological issues. According to Doel and Wang (2002, p. 445), support for technological development “as a promising means to promote national prosperity“ grew in the 1830s to 1840s, where technology became “central to national progress”. Not only was this seen as a mechanism to build and provide for society, but as a means for imperialist expansion. At the end of the 19th century, ‘technology’ was fast becoming “a key element of national policy” (Doel & Wang, 2002, p. 445). Over a century later, the arguments for technological and scientific development both in the United States and Australia continue to resonate, perhaps except for imperialism. The challenges facing nations today are quite different, yet the connection of technological development to political and policy agenda remains, as seen in previous statements in the discussion thus far.

The launch of the Sputnik satellite in 1957 represented a key event for science and technology. In the context of science and technology as a social construct, Sputnik undermined “American faith in its technology and a widespread conviction in the West that scientific and technological development within a democracy would triumph over that within a totalitarian state” (Doel & Wang, 2002, p. 453). This indicates the extent to which nations and societies ascribe significance to technologies they create, associating their success or failure with national identity and security. For America, Sputnik was a technological innovation that represented risk and inferiority, and a motivator for government to increase education funding for mathematics and science (Doel & Wang, 2002).

Also emerging around the period of the Sputnik event was the school of thought challenging the view that science occupies a privileged epistemological space (Morrison, 2014). There is broad agreement that the mid to later 20th century introduced a time where scholars from varied fields within the social sciences turned their attention to studying science (Croissant, 2015; Morrison, 2014; W. Kirk, 2018). The result was a field generally known as Science and Technology Studies (STS). Pinch (2006) notes that for many scientists the notion that science can be explained or considered in social terms is highly objectionable. Yet as Morrison (2014) describes, the loosely connected interdisciplinary field slowly grew to be known by several

variants under the STS acronym, including ‘science, technology and society studies’, ‘science and technology studies’, ‘social studies of science’ and ‘science studies’. Morrison (2014) provides this definition as a useful point of reference:

> STS scholars and scholarship focus on the situatedness of science within society-its place in political, social, and historical contexts. At the same time, STS is concerned with the effects of scientific research and technological discovery on those same social, political, and cultural contexts, including public policy.
> (Morrison, 2014, p. 2887)

Considering this definition, it can be said that STEM as a unique concept of conjoined subject disciplines is not a new idea. Moreover (and in the context of Chapter 1.1.1) that the content of STEM and technology curricula is created within the context of the public policy agendas that defined them. That is, even though the purpose of the curricula is to generate meaningful learning outcomes for students’ education, they are ultimately connected to political agendas. And still further acronyms, labels, and interpretations for the sociology of science and technology exist.

According to Morrison (2014, p. 2888), “the first major statement on science from a sociologist came from Robert K. Merton” who suggested that science operated autonomously from society. There was a separation between scientific discovery and “social and political influence” (Morrison, 2014, p. 2888). Yet this view received critique for its failure to consider the sociological components of the ‘content’ of science. This gave birth to the perspective of the Sociology of Scientific Knowledge (SSK). Morrison (2014, p. 2888) describes that SSK “focuses on the content of science”, “through the use of constructivism and many methods of empirical work”. Pinch (2006, p. 267) notes the association of SSK with Thomas Kuhn, whose work “compared scientific revolutions with political revolutions and gave room for social factors in the explanation of scientific change”. The connections and origins pointed out here are weighted towards the sciences more specifically, and they are not of primary interest to the study in this thesis. Although they do provide useful recognition that scholars have wrestled with the implications of science’s impact on society and the influence it imparts on technological development. A full exploration of the field of STS is beyond the scope of this discussion, however Morrison (2014) provides a useful summation of the schools of thought that have emerged from SSK. For brevity, a selection is listed and defined below.

- The Conflict Theory in Science – to critique the outcomes of scientific conflicts, including the outcomes that privilege and advance the powerful.
- The Strong Program of the Edinburgh School – which sought to explain how scientific knowledge develops among thought communities and from paradigm to paradigm.

- The Bath School – which sought to explain how scientific knowledge and closure of scientific controversies are created; often using micro sociological approaches including ethnomethodology.
- Laboratory Studies and Microsociological Approaches – focussing on the examination of scientists as they work before discoveries are accepted as true or invariant.
- Social Worlds – an emphasis on practice, with origins in symbolic interactionism.
(Morrison, 2014)

Further distinctions within STS are noted by Cutcliffe (2005, p. 1724); “the more practice-oriented science and technology or engineering management and policy fields”. These include,

- S&TS – Science and Technology Studies
- STPP – Science, Technology and Public Policy
- SEPP - Science, Engineering and Public Policy

An area of inquiry more directly relevant to the study reported on in this thesis includes the less well developed ‘sociology of technology’. Commentators state that “within sociology, the systematic analysis of technology has been slow to develop” (Pinch, 2006, p. 272) and that attention to this has developed only in the late 20th century (Morrison, 2014). One approach that emerged was named ‘The Social Construction of Technology’ (SCOT). Croissant (2015) provides a helpful definition.

> This model [SCOT] describes how the working of a technology is primarily dependent on the social processes leading to its manufacture and the decisions of various end user groups as to whether or not it meets their needs as they decide how to employ the new technology.
> (Croissant, 2015, p. 207)

On face value this approach reflects the processes undertaken by students within technology subjects as they respond to design briefs. Problems or needs are considered, and solutions are then developed and tested against success criteria defined by the students. Whether students in the study reported on in this thesis understand problem solving, or the development of design and technological solutions as a social process remains to be seen. Contextual variation in research sites also potentially plays a role. Technology, and the experience of technology education will mean different things to different students (Ritz & Fan, 2015; W. Kirk, 2018). This is also the source of some criticism for the SCOT model. For technologies created in one context may impart significant advantage or disadvantage when deployed in other contexts. This resonates with earlier discussion on the impacts of technological innovation in early America, where such development led to the creation of distinct social classes. W. Kirk (2018) cites Winner (1993) as a SCOT critic who pointed out the inadequacies of unexamined impacts of technology implementation. He contended that “SCOT is incapable of engaging meaningfully

with the moral implications of technology" (W. Kirk, 2018, p. 21). Although this criticism is difficult to reconcile given the above definition of SCOT.

1.2 Technology Education: Survival, Participation and Reform

1.2.1 The need to survive and thrive

In the discussion thus far, technology is presented as key curriculum area of future importance. Alongside it, STEM also continues to receive similar attention despite being a subject area of continued debate. As recently as 2018, authors are still claiming that "no clear consensus exists on the nature of the content and pedagogic interplay among STEM fields" (Holmlund et al., 2018, p. 2). Significant in this case is that the authors then also state that "given the variety of institutionalised practices and school contexts within which STEM education is enacted, we are not convinced that a single worldwide definition of STEM is critical" (Holmlund et al., 2018, p. 17). In the 2013 Kuching Declaration on Science and Technology Education, the following statement was made which outlines a scope for STEM,

> In times of global vulnerability, issues such as sustainability, health, peace, poverty alleviation, gender equity and biodiversity conservation need to be at the forefront of thinking, planning and actions related to Science, Technology, Engineering and Mathematics (STEM) education.

and that,

> The development of confident life-long learners with skills and attributes to thrive in complex societies is a high priority.
> (ICASE, 2013, p. 1)

Statements such as these present a lofty burden for the STEM disciplines, either individually or when integrated. Addressing all of the issues emerging from the above is beyond the scope of the study reported on in this thesis, however one theme resonates strongly with aforementioned definitions that note the importance of cultural context: complex societies. And not only to survive in a complex society, but to thrive in it. Accordingly, STEM (and by association, Technology) is needed to survive and thrive in a complex society. This echoes the mandate presented by the Australian 'Technologies' Curriculum which also refers to technology's impact on societies. Therefore, the question of what constitutes a complex society is also raised. Complexity implies diversity, in which a society could represent a range of values, behaviours, ages, socio-economic strata, and ethnic origins with their associated languages, traditions and values. Again, exploring all aspects of a complex society is beyond the scope of this thesis.

In addition to the above, the need to 'survive and thrive' could also be perceived as altruistic. It is possible to consider the notion to survive and thrive in the context of economic growth and competition; that is, to grow and compete. Whether this is a primary need for the development of STEM is subjective, however it does present a reason for why STEM is considered important. As previously noted, Lehman (2013, p. 12) states that STEM is "essential for national economic development, international competition and individual employment success". Yet Shernoff et al. (2017, p. 2) comment that "innovation in STEM fields drives not only economic growth but also the quality of life". In this context, innovation in STEM education could achieve a similar outcome. This resonates with Krajcik and Delen (2017) who suggest that STEM leads to meaningful and fulfilling lives, with deep usable knowledge. Similarly, the Australian Chief Scientist refers to the importance of STEM for "prosperity on all fronts"; socially, culturally and economically (Office of the Chief Scientist, 2013, p. 3). The Australian Council of Learned Academies (ACOLA) also cites that countries strong in research and development also produce superior economic growth (Marginson et al., 2013). The exact nature of this connection is not known, yet "the STEM disciplines are seen as essential for work and citizenship, while providing the cut through in global economic competition, and social creativity" (Marginson et al., 2013, p. 14). Moreover, that "the goals of lifting participation and performance in STEM should not be seen in conflict with other educational goals, such as improving reading, literacy, language acquisition, knowledge of history, society and culture" (Marginson et al., 2013, p. 69). Despite economic imperatives, the inclusion of social and cultural factors remains a consistent theme. In addition, the need for increased participation and performance in STEM is also apparent.

1.2.2 Problems of participation and performance in STEM

In the 2018 STEM Partnerships Forum final report, Australia's Chief Scientist, Dr Alan Finkel, noted that "science and mathematics education in Australian Schools is far from broken but it is clearly not where it should be" (Education Council, 2018, p. 5). In general terms, the report outlines that STEM decline is broadly identified by

1. a perception that attempting lower-level maths and science classes aids in receiving higher tertiary entrance scores (Australian Tertiary Admissions Rank, or ATAR);
2. declining standardised test scores;
3. declining interest generally.

The United States of America (USA) also suffers from STEM decline despite its position as a leading global economy. With respect to the STEM Education and STEM-Worker shortage, Stevenson (2014, p. 133) cites large scale messages such as those made by President Barack Obama,

> Reaffirming and strengthening America's role as the world's engine of scientific discovery and technological innovation is essential to meeting the challenges of this century. That's why I am committed to making the improvement of STEM education over the next decade a national priority.
> (White House, 2009, para. 4)

The timing of this message is noteworthy given the priority action proposed in a 2006 report released by the United States National Academy of Sciences, National Academy of Engineering, and Institute of Medicine (National Academies) *'Rising Above the Gathering Storm: Energizing and Employing America for a Brighter Economic Future'*. The proposed action is to,

> Action A-2: Strengthen the skills of 250,000 teachers through training and education programs at summer institutes, in master's programs, and in Advanced Placement (AP) and International Baccalaureate (IB) training programs.
> (National Academy of Sciences, 2006, p. 5)

The inclusion of IB curriculum for consideration in addressing the challenge is noteworthy, as it recognises the value of international curricula in addressing the challenge. The IB curriculum is not addressed in the study reported on in this thesis as no participants were enrolled in IB courses.

1.2.3 Curriculum reform

The discussion thus far illustrates informal and formal curriculum reform at work. Informally, the wide range of definitions for STEM indicate broad awareness and a need for change or improvement. Formally, statements made by education, scientific and political bodies have set clear agendas for the development of curricula which are essentially new with a vision for addressing global needs. Yet generally, "curriculum knowledge is constantly interpreted and reinterpreted in contexts of conception, production and implementation", and "just what constitutes improvement is contentious" (Gilbert, 2010, p. 510). With respect to STEM, a formal example of how such curriculum knowledge is 'interpreted and reinterpreted' is given in the literature review in Chapter 2.1. This example is pertinent as it was developed in response to the aforementioned needs, and in the local area context of where the study in this thesis takes place. Gilbert (2010, p. 512) notes that "sustained success of curriculum reform is poor", suggesting barriers to reform such as cultural, social, organisational, psychological, and the complex nature of curriculum itself. In the context of the study in this thesis, a factor of success includes whether students possess some perception of 'value proposition' in the subjects they

are studying. And, whether students are selecting technology subjects with a widely informed perspective.

Reform also implies innovation. The basis upon which students select a subject may also be linked to their perception of individual teacher implementation of the subject, and their positioning towards innovation in the classroom (Elliott, 1994) as cited in Gilbert (2010). Zembylas and Barker (2007) also note, research indicates that a "teacher's involvement in innovation involves personal, social and emotional responses to change which influence their commitment to reform" as cited in Gilbert (2010, p. 511). With respect to STEM as an example of curriculum reform, or innovation, the extent to which students may be exposed to wider cultural notions of STEM may therefore be impacted specifically by their teacher. This may affect the likelihood of students making connections with the value of wider cultural notions, or value, embedded in STEM. The same applies to students undertaking technology subjects generally. However, perception of individual teacher implementation of a subject could equally apply to languages students. To consider how languages may be included in innovation led reform, it first becomes necessary to consider the current rationale for languages learning.

1.3 The Rationale for Language Learning

Definition: For the purpose of the study reported on in this thesis, foreign language learning is defined by the position taken by ACARA; that the languages curriculum is "designed to enable all students in Australia to learn a language in addition to English" (ACARA, 2024b, para. 1). In recognition that "students bring their own linguistic and cultural background to their learning" (ACARA, 2024b, para. 1), the study recognises that a foreign language in this case may in fact be English, or simply a language other than the first language spoken.

In the context of STEM decline, the Australian Council of Learned Academies (ACOLA) reports that "in the last fifty years the upper secondary school curriculum in Australia has moved towards an increased scope for student selection of subjects" (Marginson et al., 2013, p. 79). Similar to statements made by the Chief Scientist, it is suggested that this has led to students choosing subjects of interest, or those in which they excel, or those which will assist them in achieving higher Australian Tertiary Admission Ranks (ATAR). Significantly, however, ACOLA notes against this backdrop that,

> There are other concerns. The number of students doing foreign languages is low and has reduced as a proportion of the senior secondary cohort.
> (Marginson et al., 2013, p. 79)

To address the above concern, ACOLA suggests “a common comprehensive approach to years 11 and 12 [that] might involve all students doing English, mathematics to at least intermediate level, at least one science subject, and a foreign language” (Marginson et al., 2013, p. 79). However, ACOLA states that “issues of common curriculum and compulsory languages are beyond the ultimate scope” of the 2013 report (Marginson et al., 2013, p. 79). However, this concept forms an area of interest for the study reported on in this thesis, and the following statement provides helpful context,

> The interdependence of countries and communities means people in all spheres of life are required to negotiate experiences and meanings across languages and cultures. Despite its status as a world language, a capability in English only is no longer sufficient. A bilingual or plurilingual capability is the norm in most parts of the world. (ACARA, 2024c, Rationale, para. 3)

The above statement sits awkwardly with recent Australian census data. As Scrimgeour (2022, p. 6) points out with reference to 2021 census data, there is a “rich diversity and regional variability in languages spoken at home in Australia” as a result of continued strength in migration. Given this diversity, language learning programs in Australian education could easily co-exist with other subjects considered to be mainstream. A nation consisting of diverse cultures and languages presents a strong rationale for vibrant languages programs. However, the landscape remains challenged with lower proportions of students continuing with languages learning beyond mandatory requirements in Australia and other Anglophone countries (Mason & Hajek, 2021). Related to observations by ACOLA and the Office of the Chief Scientist, Mason and Hajek (2021, p. 136) note that “around the English-speaking world, apathy and antipathy toward multicultural diversity and difference show signs of increasing”. Examples of such indifference appear in wider commentary and in smaller-scale studies.

In the Australian context on a scale closer to that reported in this thesis, a study by Black et al. (2018) exemplifies the challenges. The authors state that despite the recognised need for greater language capabilities and intercultural understanding both locally and internationally, “language learning in schools struggles for recognition and support” Black et al. (2018, p. 1). The study took place in two schools described as ‘residual’ comprehensive high schools with declining enrolments. Reasons cited for the decline included “competitive, market-based pressures of selective schooling and increased parental choice” (Black et al., 2018, p. 6). As an example, the study contributes to the discussion by highlighting the gap between high-level goals for languages learning and the realities faced at school level. As stated in section 1.0, the dilemma of allocating resources to subjects remains a challenge for teachers and school leaders. The study by Black et al. (2018) reveals how staffing is often limited to the availability and experience of teachers in terms of which languages are offered, and the perceptions held by principals in terms of the benefits offered by languages. Teachers also cited pressure from

languages perceived to have higher value from a business or commercial perspective such as Asian languages, which tended to be favoured over Latin languages. This indicates not only a struggle within languages learning generally, but also a struggle between the languages for 'market share' amongst students. At one of the research sites within the study, the choice of offering Mandarin "was seen as a marketing opportunity for the school" (Black et al., 2018, p. 10). This is noteworthy as such motivation introduces the concept of value perception where teachers and school leaders saw opportunity for future value yet struggled to convert it into value shared by students.

The notion that languages have marketing value, or that competency in a foreign language can be a competitive advantage has existed for many decades. This adds to a rationale for languages learning, however it is also hampered by changes in policy discourse over time. Mason and Hajek (2021) provide a helpful summary of policies and programs within Australia which highlight the variations. They report seven national policies or programs between 1988 – 2018 covering a range of goals and targets including,

- enhancing language programs in state and private sectors from Kindergarten to Year 12.
- Ensuring all Australian school children have access to learning Asian languages.
- Expanding and improving the learning of languages other than English.
- Improving participation and proficiency in Asian languages.
- Establishing long term directions for languages education.
- Significantly increasing the number of Australian students proficient in languages and cultural understanding of Australia's nearest Asian neighbours.
- Encouraging Australian students to take a continuous course of study in an Asian language throughout their schooling.
- To revive the teaching of foreign languages such that at least 40% of Year 12 students are studying a language other than English.

(Mason & Hajek, 2021, pp. 139-141)

A detailed discussion of the above programs is beyond the scope of this introduction; however, it provides insight into the myriad variations that languages policy has undergone in recent decades and the influence of market-based or economic rationale. Coupled with changing leadership over this period (Mason & Hajek, 2021) it becomes clearer as to how principals and teachers at the local level might struggle to gain traction on any one of these initiatives. Accordingly, staffing and resource allocation for languages learning remains a dilemma.

The policies and programs listed above, and the dilemma which remains today are noteworthy in the context of The National Policy on Languages (1987) in Australia. Prior to the programs above, Lo Bianco (1987) states in an overview of the policy that "all societies undertake actions which influence and direct language" and that there is "a socio-political context to all language

planning" (Lo Bianco, 1987, p. 1). Moreover that the goals of the policy are "summarised as enrichment, economic opportunities, external relations and equality" (Lo Bianco, 1987, p. 4). When considering the rationale for languages learning in the context faced by school students today, the statement by ACARA above remains broadly consistent with the National Policy, despite the various programs that have existed over time. At high-level, it becomes apparent that languages learning in Australian schools has attracted the attention of policy makers who present bold goals, yet the implementation of those policies has not connected with learners to translate into increased participation in languages learning. Mason and Hajek (2021) make the observation that "perceptions play a key role in the decision-making process of various stakeholders in language education" (p. 146) and that for some students there simply may not be the interest or motivation. This resonates with previous comments about lower numbers of students selecting STEM subjects due to lack of interest generally, or the perception that other subjects in which students can excel will lead to better performance. As Mason and Hajek (2021) state, some students "do not see the relevance or importance of language learning, or find it difficult or boring" (p. 146).

The observations by Mason and Hajek (2021) above are made within the context of languages learning in primary education. Whilst commentary thus far has placed the rationale for languages learning mostly in a wider global context leading to economic and competitive outcomes, Mason and Hajek (2021) suggest a need to consider primary languages education "where there is also increasing anxiety about improving literacy and numeracy outcomes in English" (p. 148). Whilst not immediately obvious for the purposes of improving literacy generally, acquiring a foreign language has received much attention for developing literacy and numeracy skills. Cordy and Morgan (2022) cite extant literature on the benefits of bi/multi/plurilingualism. They claim that "benefits include cognitive and learning benefits, and literacy advantages which are evidenced in the classroom and in education testing regimens" (Cordy & Morgan, 2022, p. 27). The authors cite data from the Australian National Assessment Program: Literacy and Numeracy (NAPLAN) and compare results with students categorised as being from a language background other than English (LBOTE). Cordy and Morgan (2022) acknowledge that results from standardised testing and the conclusions drawn can be controversial but that "great store is often placed in these tests by governments and education departments" (p. 28). However, the authors assert that bilingual children possess the capability to cross-reference between two different "systems of grammars or rules around how languages are constructed" (Cordy & Morgan, 2022, p. 27). Moreover, that this ability to cross-reference enhances other skills such as executive function, with positive effects on the ability to plan, maintain focused attention and multi-task. In the context of NAPLAN performance,

> the data show that students from a language background other than English typically develop the necessary skills and knowledge in Standard Australian English literacy (as tested by NAPLAN) earlier than students from English only backgrounds.

(Cordy & Morgan, 2022, p. 37)

The authors suggest that these findings present a strong case for providing access to languages learning for all students in order to gain from the benefits of bilingualism. This would suggest another strong rationale for languages learning. However, the challenge, they contend, is one that should again be directed to policy makers and school leaders to effect the change. Given the discussion above, this is likely to result in similar obstacles experienced in policy implementation and leadership change. In addition, communicating the value proposition of learning a foreign language to Australian primary school children for improved English literacy skills may be equally difficult.

Whereas the study by Cordy and Morgan (2022) reports on students with a Language Background Other Than English, Fielding and Harbon (2022) also report English literacy gains in students participating in bilingual programs whereby subject content is taught in a target language. In the context of this thesis, it is not suggested that technology students should adopt a foreign language, nor that languages students should study technology subjects, nor that students should necessarily attend bilingual classes. What makes the concept of a bilingual program of interest to this thesis is that benefits can be found in unlikely scenarios. Quantitative analysis of NAPLAN data revealed significant gains where students in the bilingual stream at four schools outperformed their non-bilingual peers. This was consistent for students in Years 3 and 5. Conversely, the researchers also noted “that there is no detriment to student NAPLAN results because of participation in the bilingual programme” (Fielding & Harbon, 2022, p. 1010). Even if a student discontinues languages learning at an early stage in school, the literacy gains achieved may well have been worth it.

Whilst standardised test data often take centre stage when assessing student progress, the second research question posed by the Fielding and Harbon (2022) study examines “Teacher perception of literacy in CLIL contexts” (p. 1012). Given the discussion of languages rationale thus far, the question of teacher perception is possibly unfairly placed below questions related to performance and attrition in languages learning. For without strong teacher support, it is less likely for value propositions (either obvious or less obvious) to be effectively communicated. Feedback from teachers was broadly positive about their perception of literacy learning achieved by students in the bilingual programme. The statistical findings were clear, yet the researchers note,

> Even when teachers found it difficult to quantify the link between language learning and literacy development, they still highlighted the metalinguistic awareness and cross linguistic transfer that is developed in the students in the bilingual programme.
> (Fielding & Harbon, 2022, p. 1013)

The study suggests that value is present both in measurable performance statistics, and in 'less measurable' teacher perception. An area in which the study could have been extended is 'student' perception of value to gain a deeper understanding of the experiences of students. For what teachers think is valuable for Year 3 and 5 students in terms of 'literacy development' may not be shared by the students themselves. However, the study does present a compelling contributor to the rationale for languages learning, particularly in the early years of schooling.

1.4 Perceptions of Learning

The discussion thus far of a rationale for languages learning presents broad goals and targeted programs that struggled to gain traction with school students. At the same time, it is apparent that perception of languages learning varies greatly amongst administrators, teachers, and students. A perspective on how this might be addressed is presented by Liddicoat et al. (2018, p. 3) who investigated the concept of "new models of Languages provision" facilitated by a "curriculum innovation project". The authors examine the way in which school structure, culture, and organisation "influenced what was possible in terms of change and ultimately the sustainability of change, particularly in relation to a learning area that is perceived to be 'specialist'" (Liddicoat et al., 2018, p. 3). The study contributes to this introductory discussion as it took place in three Australian schools, representing a similar scope to the schools reported on in this thesis. The project was categorised as 'innovative', however the authors do not define an approach or framework for innovation. In addition to new teaching programs and associated resources for languages learning, the authors also note that curriculum change in this project involved "finding ways of integrating the new models of provision into the existing curriculum of the schools" (Liddicoat et al., 2018, p. 3). Challenges surrounding the introduction of new innovations into existing systems without a clear articulation of the nature of the innovation are discussed further in Chapter 2.8 and Chapter 2.9.

From a broad perspective, Liddicoat et al. (2018) contend that schools are socially constructed in a way that is unique to each school, yet still within a system for education. As such, schools are inherently complex existing within broad and socially diverse societal communities. Within this context, languages as a learning area suffers the complexity of,

- being seen as less integral to the overall curriculum and overall learning experience of students;
- being enmeshed within an ideological framing of education as a monolingual (English-only) endeavour;
- existing in a context where there is a lack of tradition of continuous learning across the entire span of schooling

  (Liddicoat et al., 2018, p. 4)

The nature of how innovation is introduced into a complex environment as described by the points above is an important factor in the success of the innovation. Liddicoat et al. (2018) state that there is extant literature on the impact of school leadership on change, however that their study differs in that change was largely driven by teachers. As will be explored further in Chapters 2.8 and 2.9, this indicates an approach towards innovation that could be described as 'disruptive'. This is because change was driven by people who might be considered to have less power or influence within the 'system'. Outcomes from the project demonstrated that leadership was able to effect change where "the vision for something different is clear and the case can be made with staff" (Liddicoat et al., 2018, p. 12). In the case where structural obstacles could not be overcome by leadership, change was implemented by teachers however was ultimately unsustainable due to the lack of requisite influence within the system (Liddicoat et al., 2018).

The project did not contest a rationale for languages learning and considered change from the perspective of school structure, curriculum planning and staffing. There was, however, a barrier in that the 'perception' of languages learning was once again expressed as being a learning area that did not rank highly as a priority (Liddicoat et al., 2018, p. 12). Where that perception originated or why the participants held those perceptions is not made clear and highlights an opening for further investigation. For if there is no value to be perceived, then it is likely that there would be no languages learners, nor languages teachers. Yet there are some languages students, and some languages teachers. Moreover, languages are still a mandatory component of the curriculum. Languages students and teachers could therefore be seen as operating at the 'fringe' of the curriculum. With reference to the marketability of languages or the economic rationale of knowing a language of a foreign trading partner, languages students could be considered 'fringe customers'.

A study by Kavadias et al. (2022) provides a further example of an investigation similar in size and scope to that reported in this thesis. The study examines experiences of Australian tertiary students who either continued or discontinued their studies of Italian from secondary school. Researchers in the study also cite "high attrition rates in language studies in general" and "breakdowns in student retention and motivation" as factors that need to be understood in addition to those that contribute to positive outcomes (Kavadias et al., 2022, pp. 450-451). The study claims to focus less on motivation and takes a "more practical approach" to offer findings that are "directly helpful to policymakers, schools, and educators as well as scholars" (p. 451). The study does not consider findings using an 'innovation' framework. However, it contributes to this discussion in that it investigated 'incentives' which would encourage students to continue with Italian at secondary and tertiary level. For this discussion, two most cited incentives are noteworthy and included,

- multilingualism being perceived as valuable to employers and increased job opportunities for Italian;

- change in discourse from early on in schools to increase the value of the subject instead of making it seem difficult and only for skilled students.
  (Kavadias et al., 2022, p. 463)

Against this backdrop, participants reported that teaching staff were considered to be “the most contributing factor to their decision to continue or discontinue Italian study throughout secondary education” (Kavadias et al., 2022, p. 466). The school environment and the perceived usefulness of Italian were also cited as contributing factors. However, the finding that teachers play such a key role offers an opening for further action similar to that reported by Liddicoat et al. (2018) whereby teachers choose to become the initiators of change and the communicators of the above incentives. This thesis explores that concept by pressing further into understanding how students conceptualise their subjects, where student value perception originates, and how to leverage that value perception.

To facilitate exploration described above, a unique approach is taken whereby participants respond to focus questions and produce visual data within a structured method, but with the freedom they need to fully express themselves. An example of how this differs from approaches taken in other research is in the study by Mativo et al. (2013) which explored the perceptions of engineering students in United States of America (USA) high schools. The Mativo et al. (2013) study examined survey data from 344 students across high schools in the state of Georgia, USA. Students were presented with twenty survey items about their perceptions of the engineering courses they took and responded using a Likert scale ranging 1=strongly disagree, to 4=strongly agree. Responses were ranked and analysed with descriptive statistics. The notable aspect of an approach such as this is that the researchers implicitly place or ascribe value to aspects of the courses in the items that are presented. The perception of learning is therefore guided to some extent by the nature of the items. A case in point is survey Item 1 “This course prepares me for employment” (Mativo et al., 2013, p. 110). The authors note in their introductory discussion that the study is placed within a context of international competition and economic development. It also takes cues from the Australian Prime Minister’s Science, Engineering, and Innovation Council (PMSEIC) as an influencing factor in Australian engineering education. The researchers state that “part of the PMSEIC’s task is to encourage the four learning strands that are seen as vital to the country’s education for a competitive Australia (Mativo et al., 2013, p. 104). In that context, it can be argued that Item 1 sets an appropriate tone for the investigation. Indeed, seven items in the study are related to career or vocational perceptions; Items 1, 2, 8, 9, 10, 19, 20 (Mativo et al., 2013, p. 110). Results were summarised into two factors describing students’ perceptions: (1) Educational Value of the Course, (2) Personal Relevance of the Course. Noteworthy is that the two highest ranking reasons for enrolling in the engineering course were “Interested in the subject” (35.4%), and “Thought it would help me in college” (17.4%) which were both categorised as factors of ‘Personal Relevance of the Course’ (Mativo et al., 2013, p. 109). Despite the study being

conducted in the context of economic and vocational rationale, the vocational aspect was not dominant in the responses.

A further example of how the study in this thesis differs from other research is found in the study by Heyder et al. (2017) which examined boys' lower language grades. It applied the expectancy-value model whilst also "taking into account students' motivational beliefs as well as their aptitude" (Heyder et al., 2017, p. 205). Whilst considering a range of factors, the key difference in the study was that researchers focused on grades as they were "considered the most ecologically valid measure of achievement" (Heyder et al., 2017, p. 209) and analysed results with descriptive statistics. The study reported on in this thesis does not consider grades or achievement. Nor does it require students to 'correctly' explain or represent the curriculum. Without the criteria of grades or curriculum, this study enables participants to freely express a conceptualisation of their subject and express value propositions emerging from that conceptualisation. Participants are therefore able to fully express what is meaningful to them without any tone or agenda set by survey questions.

1.5 Research Questions

To address the preceding discussion, the study asks the following primary research question.

- How do students conceptualise Technology and Languages subjects they study, independently from notions of assessment or curriculum?

Underlying the primary research question, the study also asks,

- To what extent did value propositions presented by those subjects, and resulting from the conceptualisation strategy, motivate students to study those subjects?
- To what extent do complimentary value propositions between languages and technology subjects exist, and how do students express this?

Objectives

The research questions above aim to address three main objectives of the study. Essentially to investigate,

- **Conceptualisation** – to investigate how technology and languages students conceptualise their subjects.
- **Opportunity** – to determine how students identify value in their subjects, where new value may exist, and how that value can be leveraged.
- **Understanding** – how students make sense of overlapping value propositions in technology and languages subjects, and the potential synergies (or lack thereof) between these two subject areas.

The study draws on the theoretical frame of disruptive innovation (Christensen, 2013) and the method of concept mapping (Novak, 1995). The study acknowledges research carried out by Holmlund et al. (2018, p. 3) in which concept mapping and the frame of sensemaking were used to investigate “ways in which individuals are navigating the complex and novel ideas inherent in STEM education”. They contend that “sensemaking begins with a real or perceived disruption to the status quo” which may involve “radical innovation in curriculum and instruction” (Holmlund et al., 2018, p. 3). The study in this thesis includes STEM in the broader offering of ‘technology’ subjects in the research contexts. Concept mapping is used in this study to investigate conceptualisation in technology/STEM and languages subjects to uncover opportunities for new value through the disruptive innovation lens. To contribute to new knowledge applicable to schools and students facing the dilemma presented in the opening discussion (Chapter 1.0), the disruptive innovation frame must be applied to,

- Better equip schools to address the critical factor of resource allocation by considering opportunities for new value. Without it, they risk staying ‘stuck’ in what Christensen et al. (2004) describe as asymmetry of motivation: i.e. knowing that resources need to be allocated in recognised areas of need, but also to satisfy demand of more popular subjects whilst only having limited resources to do so.
- Equip students with skills to identify unseen or unknown value propositions that could significantly broaden their experience or widen their scope for subject selection.

Chapter 2: Literature Review and Conceptual Frame

The study reported on in this thesis considers the value propositions found in secondary technology and languages subjects. The investigation focussed on how students conceptualise their subjects and what value propositions presented by those subjects, as perceived by students, motivated the students to study them. It addresses the dilemma facing school administrations of resourcing subject learning areas with declining participation, and challenges of staffing and resourcing. The introductory discussion also sets the study within themes for technology and languages education including 'global, social, cultural, integrated, humanity, balanced', and it therefore becomes necessary to explore both local and global contexts. This study focuses on three regionally diverse, independent K-12 coeducational Christian schools in Australia. Schools A and C are in New South Wales (NSW), and School B is in the Australian Capital Territory (ACT). The study takes an interpretivist perspective, focussing deeply on the actual experiences of educators and students within these contexts.

The subject category of 'technology' is broad, encompassing many varied disciplines, and this study includes the emerging curriculum of STEM under the umbrella of 'technology subjects'. By contrast, languages as a subject experiences fewer challenges with respect to definition and scope. Participants at School A comprised only STEM students, working from a specifically designed and endorsed STEM syllabus delivered by the Technological and Applied Studies faculty. Moreover, the syllabus was developed in the same region as the research site. As such, this literature review will first discuss this STEM syllabus to establish how STEM is implemented in the context of the study.

To build towards a conceptual frame for discussing findings, this review also explores other factors surrounding the implementation of technology and languages which may inform conceptualisation of, or value perception in those subject areas. These include how 'technologies' may have language characteristics of their own and carry pre-existing cultural and gender biases which influence participation within schools. Given the far reaching rationales and goals set forth for both technology (ACARA, 2024d, Introduction, p. 1) and languages (ACARA, 2024c, Rationale, para. 3) the review will consider the wider global context and the impact of intercultural notions embedded within the two subject areas. Since STEM is a more easily and widely recognised moniker for 'technology education' globally, the review leans on notions of STEM in the wider literature as a proxy for what is more broadly recognised as 'technology education' at the research sites. At this point, languages learning contributes to the review through the recognition of value in 'intercultural awareness' and the development of bilingual programs. As these factors are explored, the emergence of innovation is acknowledged as a recurring approach to reform and improvement. The review examines the unique nature of 'disruptive' innovation as a frame for analysing the findings in this study with a view to addressing new value in student subject selection and the dilemma stated in the

introduction to this thesis. The difference between sustaining and disruptive (incremental vs breakthrough) innovations is illustrated through examples in education contexts to set out the frame used for Chapter 5 Discussion of this thesis.

2.1 STEM in the Research Context

'School A' is located in the Newcastle / Lower Hunter Region, north of Sydney, with a population of approximately 400,000 (Australian Bureau of Statistics, 2023). What makes this school a unique starting point for investigation is that a specific STEM syllabus was developed in and for this region. Known as 'iSTEM', it is a syllabus developed in collaboration between Regional Development Australia Hunter, local industry, and STEM teachers at Maitland Grossman High School (Regional Development Australia Hunter, 2019b). It was developed as part of the ME Program, which is the Australian Government's Department of Defence Schools Pathways Programme and caters for students in Stage 5 (years 9 and 10 in high school). The ME Program's website tagline, "RDA Hunter's ME Program helps build an industry skilled, homegrown Hunter workforce", makes clear the importance of this initiative to the local context (Regional Development Australia Hunter, 2019a). As at the time of writing, endorsement for the version of the course that participants at School A were studying expired in 2022. From 2022, schools were transitioned to the new iSTEM course (Education Standards Authority, 2023a).

The rationale for the iSTEM syllabus studied by School A participants at the time of the study echoes the concerns of the introductory discussion by claiming that STEM is "fundamental to shaping the future of Australia", and that Australia will need "more employees trained in science, technology, engineering and mathematics (STEM)" (NSW Department of Education, 2021, p. 2). Of particular interest in this research study is the place of cultural and global components that have been factored into this syllabus. The objectives for the course provide insight and are listed as follows.

SKILLS

Students will develop:

1. Initiative, entrepreneurship, resilience and cognitive flexibility through the completion of practical STEM based activities.
2. Planning and project management skills using iterative and collaborative design processes.
3. Communication and critical evaluation skills, working both independently and collaboratively.
4. Problem solving and decision-making skills in a range of STEM contexts.

KNOWLEDGE AND UNDERSTANDING

Students will develop knowledge and understanding of:

5. the application of cognitive processes to address real world STEM based problems.
6. STEM education principles and processes.

VALUES AND ATTITUDES

Students will develop:

7. An appreciation of the value of STEM in the world in which they live.
8. An appreciation of the importance of working collaboratively, cooperatively, and respectfully.

(NSW Department of Education, 2021, p. 12)

These objectives are consistent with the syllabus aim; “to promote the areas of science, technology, engineering and mathematics through the study of technology, engineering, skills and mechanics” (NSW Department of Education, 2021, p. 8). A potential opening for the consideration of cultural and wider global factors exists in objectives 5 and 7, which uses language such as ‘real world problems’ and ‘the world in which they live’. The document makes no further reference as to what this language might mean, whether these objectives are STEM specific, or how knowledge about these concepts might be constructed. Although the course structure indicates that elective modules within the course “have been developed as alternatives for schools in order for the course to better cater for the individualised needs of the students in the local area” (NSW Department of Education, 2021, p. 7). The intended interpretivist approach utilised in the research in this thesis offers an opportunity to explore how both teachers and students interpret ‘the world in which they live’ through the experiences offered by the course; whether the ‘world in which they live’ is defined by their ‘local area’, or a global view, and how this knowledge is constructed and expressed. The notion of ‘real world problems’ also presumes a view wider than Australia.

Notably, the iSTEM syllabus “aims to increase the participation rate of female students” (NSW Department of Education, 2021, p. 8). This indicates an awareness of perceived gender imbalance in the selection of STEM subjects which is addressed “via the use of engaging learning and teaching customised to meet the individualised learning needs of students” (NSW Department of Education, 2021, p. 8). However, on face value, all students benefit from engaging learning and teaching customised to individualised learning needs, regardless of gender. The balance of gender participation is not a point of investigation for this study; however, it is possible that conceptualisations between participants may be gender specific. Studies addressing gender in STEM are discussed further in Chapter 2.3.

2.2 The Language of STEM

It is noteworthy that some scholars have considered the notion that STEM has a language of its own, and that this impacts its adoption and implementation. This is worth considering in the context of value in technology/STEM and foreign language learning pathways, as learning the 'language of STEM' may in fact be an initial hurdle to overcome. It is discussed here briefly since STEM forms a notable component of the broader umbrella of technology subjects and was the specific subject studied by participants at School A.

In the wider context, a conceptual paper by Collier et al. (2016, p. 522) claims to reveal the "presence of IQism" among American youth and young adults, suggesting that STEM is a field reserved for "the best and the brightest"; an intellectual elitism. What makes the paper relevant to the research in this thesis is the proposal that second language acquisition (SLA) strategies can improve the teaching of STEM to students whose first language is 'informal English' (Collier et al., 2016). By using the term 'informal English' the authors are not referring explicitly to what might be described as poor English, but to a form of English that is shaped by culture and experience. They cite Xie et al. (2015) who "highlighted literature which reveals that while family, school, neighbourhood, culture and cognition levels determine academic outcomes for both STEM as well as non-STEM courses, social psychological variables are particularly significant determinants of STEM achievement" (Collier et al., 2016, p. 259). Moreover, the authors note that "in California and other states, more than half of the children now entering public schools come from households where the first language is not English" (Collier et al., 2016, p. 260) and that language, culture and ethnicity are intertwined into STEM participation and success in some contexts. The authors therefore argue "for the merging of two distinct, yet potentially complementary fields – science, technology, engineering and mathematics (STEM) and best practices and pedagogy from the Teaching of English as a Second Language (TESOL)" (Collier et al., 2016, p. 259) as a way to drive improvement. This thesis does not propose that technology participants in the study should be exposed to greater languages (or English) learning to improve outcomes. However, it is noteworthy that the manner in which language was used in the context described by Xie et al. (2015) made appreciable impact on student learning.

Other scholars have noted "linguistic and cultural gaps in K-12 STEM pedagogy and practice" with respect to STEM professional development (Charity Hudley & Mallinson, 2017, p. 637). Similar to findings by Collier et al. (2016), Charity Hudley and Mallinson (2017) report challenges in engaging African-American students in K-12 students due to a lack of culturally and linguistically responsive approaches. The authors do not suggest that these approaches should lead to foreign language acquisition as part of a STEM learning pathway. Rather, they seek to "equip all educators to understand linguistic and cultural variations within English language patterns due to differences in students' regional, racial/ethnic, and social class

backgrounds" (Charity Hudley & Mallinson, 2017, p. 639). Moreover, the authors make this point; "culturally and linguistically diverse students do not leave their language patterns at the door when they enter STEM classrooms" (p. 639).

2.3 The Role of 'Gender'

The iSTEM syllabus described in Chapter 2.1 makes a case for increased participation of female students. With respect to a potential critique of the syllabus, Yates (2010, p. 495) states, the label of critical theory "is usually restricted to work that assumes an explicit critique of the current form of society as a foundation from which the analysis of curriculum begins". This thesis does not take a critical perspective, and an analysis of the syllabi of subjects studied is not within the scope of the study. However, it is pertinent to also consider issues of gender, given that a specific purpose of the iSTEM syllabus is to increase the participation rate of female students in STEM courses. No specific guidelines are provided in the syllabus as to how individualised learning needs are implemented specifically for female students. At the same time, nor are they specified for male students. Whilst the intention may be genuine, it does raise the question as to why the intention needs to exist in the first place and what has caused the low participation rate of females in STEM courses. Whether this is due to a form of 'elitism' (similar to IQism), or some kind of gender marginalisation is worth considering.

In their work on developing cultural and linguistic competence in teachers, Charity Hudley and Mallinson (2017) propose the concept of communicative burden in the context of language barriers. They contend that "communicative norms and expectations shape and are shaped by our culture" (Charity Hudley & Mallinson, 2017, p. 644). When disproportionate burdens occur between people, challenge arises between students and teachers particularly when age and status are involved (Charity Hudley & Mallinson, 2017). This may also apply to gender. In the context of language barrier, the authors suggest that simple sentences such as "I can't understand you" can in fact create offence, and a sense "that their language is being devalued, and by proxy, their identities" (Charity Hudley & Mallinson, 2017, p. 644). They conclude that the negative message "about language can be experienced as *linguistic microaggressions*" (Charity Hudley & Mallinson, 2017, p. 644). That the microaggression can be *experienced* suggests a real and tangible event that leads to consequences. This has implications for the desire to increase the female participation rate as noted in the iSTEM syllabus used by participants in this study. If the field is male dominated, the explicit aim to increase female participation could be interpreted to make females join what the authors of the syllabus might consider as a male domain. It could be a genuine recognition of female contribution, or a *microaggression* that makes a veiled attempt at equity. An awareness of this concept contributes to this literature review. It suggests that the language of interaction used in the current (or any) local STEM education context may be an obstacle before even starting to

consider the wider global context. This is noteworthy given that there were no female students in the class from which iSTEM students participated, despite the school being coeducational. Gender imbalance between the technology and languages participants in this study is not a focus of investigation, however it is acknowledged that forces such as those described above may be at play since there is direct reference to increased female participation in the iSTEM syllabus. A reciprocal discussion of gender balance amongst languages participants is therefore beyond the scope of this review.

The above example also resonates with further observations by Yates (2010, p. 496), noting that feminist critical perspectives emergent from the 1970s see curriculum as a potential method for "transmitting inequalities and subordination related to gender", and that "a feminist critical perspective was not just about adding women in to a curriculum story or an array of subjects that remain unchanged". Whilst not primarily concerned with achieving social change, cognisance of such critical factors will contribute by what Yates (2010, p. 498) describes as "maintaining a critical watch on curriculum, revealing undesired social effects that are produced by it." How this can be useful is reflected in the following study, noting that it was conducted nearly 50 years since the emergence of feminist critical theory.

A study by Rainey et al. (2018) provides further insight by considering the intersectionality between race and gender with respect to a sense of belonging in STEM fields. Taking a critical perspective, using mixed methods for data collection, the study used a subset of a larger study to complete a quantitative analysis of 201 tertiary student interviews. The students were currently or formerly studying a STEM major in the University of North Carolina, USA. The authors consider their study unique in that they "consider race and gender as well as their intersections, in contrast to most studies which consider only one dimension or the other" (Rainey et al., 2018, p. 2). The authors contend that this approach addresses a gap in the literature in that "many studies regarding gender differences do not investigate racial identities, as many studies are done at predominantly white institutions" resulting in "data about "women" that is only true for white women" (Rainey et al., 2018, p. 2). This resonates with the proposed research sites for this study in that the three schools targeted have predominantly white European communities. This does not delegitimise the research sites but does prevent findings from being broadly generalisable. Whilst not specifically related to foreign language acquisition, the study by Rainey et al. (2018) contributes in that it signals the potential benefit of considering the intersection of factors, rather than in isolation. Moreover, that there is potentially a danger in not recognising the predominantly white European context. This also suggests the need for an awareness of de-colonising perspectives, to which this review now turns.

2.4 Consideration of De-colonising Perspectives

A study by Hernandez et al. (2016) takes a de-colonising perspective to the socio cultural and familial experiences of Latino students and how these factors influence choice of STEM subjects in USA schools. It explores differences between European and Latin American perceptions of STEM education and career pathways. A mixed method study, it includes focus groups with 52 parents, surveys from workshops, panel discussions and STEM hands-on activities with participant numbers ranging from 11 to 763 at each event. In-depth interviews were conducted with 7 parents. Hernandez et al. (2016, p. 356) observe that "for American school staff, education is tightly linked to instruction and academics, whereas for Latinos "educación" tends to be a more well-rounded notion involving politeness, good manners, respect to elders, good behaviour and being a good student". The study seeks to understand the "culturally driven set of norms" that Latino families bring to the American education context, and therefore focuses on themes emerging from the study (there was no statistical analysis)" (Hernandez et al., 2016, p. 356). These include, "families' educational values and beliefs about education", "family interest and awareness in college choices", and "beliefs awareness and interest" in STEM (Hernandez et al., 2016, p. 356).

The study makes no specific reference to the intersection of gender, as in the study by Rainey et al. (2018). However, the discussion of findings suggests that "educational stakeholders should pay closer attention to the role of other moral, personal and social values and their influence in schooling (Hernandez et al., 2016, p. 364); arguably an ontology promoting multiple realities, with a rich multifactorial approach to education. It is therefore worth considering that a lack of 'attention' by school administrators in the target research sites has potentially contributed to the aforementioned homogenous student mix, and that this study may in fact reveal knowledge constructed with a narrow white European perspective. The findings by Hernandez et al. (2016) therefore make a relevant contribution to this literature review. Whilst the study focuses on STEM and not languages, it suggests an element of value that is brought to STEM (and by implication, technology) education through cultural and language appreciation that is not specifically technological, yet still valuable. It is the less considered, or less obvious value propositions presented by technology or language participants that are of interest in this thesis. The study by Hernandez et al. (2016) illustrates how such value may become evident. Moreover, how participants identify such value could inform future teaching practice.

A useful comparison at this juncture is the study by Srikoom et al. (2017). Taking a positivist approach, the study surveyed 154 K-12 teachers from 27 public and 12 private schools across Thailand. Teacher age ranged from 23-68. Results were analysed with descriptive statistics, and interpretive methods were used to analyse open ended questions within the survey. The purpose was to investigate initial in-service teacher perceptions of STEM where it was being introduced as a new pedagogic approach. Where the studies like those of Holmlund et al. (2018), Rainey et al. (2018) and Hernandez et al. (2016) embrace an ontology of multiple realities for STEM and approaches for implementation, Srikoom et al. (2017) are more

interested in STEM as a single reality; one that needs to be discovered and understood for successful implementation. A strength of the study is the broad context of participants covering public and private schools from K-12 across Thailand. However, considering the studies discussed above, the lack of indigenous perspective is noteworthy. Given the newness of STEM in Thai education, it could have been an opportunity to investigate local cultural perspectives on what STEM education means. This could include the potential contributions of the Thai cultural and linguistic context to the development of STEM programs.

Notwithstanding the perspective, methods of data collection, and the lack of indigenous perspective, the study by Srikoom et al. (2017) is pertinent. The authors concede that their findings are more suited to "mass and official communication" (Srikoom et al., 2017, p. 14). This supports the intention to explore the actual experiences of teachers and students through the interpretivist lens, given that the research reported on in this thesis seeks to investigate only three sites. In addition, and perhaps more significantly, findings indicated that perceptions of STEM varied greatly. The single STEM acronym was investigated, yet a single reality was not uncovered. Lack of guidelines or a specific model were cited as significant challenges to constructing knowledge about STEM as a new pedagogy. Another element is therefore introduced to the investigation; newness, and innovation. Moreover, how teachers and students process, participate in, or implement seemingly distinct disciplines in an integrated model. How teachers process the forces of innovation required to implement such a model also requires consideration.

2.5 Positioning Towards Educational Innovation

In a conceptual paper by We et al. (2017, p. 202), the authors contend that "innovations can differ in their starting points (top-down vs grassroots-initiated), scale, complexity and nature". Moreover, they cite the OECD Centre for Educational Research and Innovation (CERI) which "identifies four types of innovation: product, process, marketing, and organisational" (OECD Centre for Educational Research and Innovation (CERI), 2008) in We et al. (2017, p. 202). The authors stress that their analysis focuses on innovations that are research backed and refer to 'process' innovations that in the educational context, lead to "new or significantly improved" pedagogies (We et al., 2017, p. 202). Whilst many interpretations of 'innovation' likely exist, the definition offered is a useful starting point, and resonates with studies like Srikoom et al. (2017) where initiatives like STEM are introduced as 'new' pedagogies. Disruptive innovation, as described in Chapter 1.0 is also a research backed type of innovation (Christensen, 2013), although We et al. (2017) do not reference it.

We et al. (2017) suggest that some teachers embrace innovations, whilst others give superficial attention to, misconstrue or resist them. Furthermore, the researchers recognise broad extant

research on topics of teacher motivation, beliefs, and attitudes and sensemaking. Yet, We et al. (2017, p. 204) claim that “a framework describing the affective and cognitive thought processes, and the type of sensemaking and decision making ongoing about innovation within teachers, at various stages of the appropriation process does not yet exist”. They cite Spillane et al. (2002) who describe “collective sensemaking as teachers coming together, focussing on problems of shared concern” and that in doing so “teachers are introduced to alternative interpretations” of innovation (We et al., 2017, p. 204). This is noteworthy given that Spillane et al. (2002) argue that “collective sensemaking will always occur, with or without formal structures”, (i.e. ‘frameworks’) and that “left to their own, teachers will seek out like-minded groups to affirm their views on educational innovation” (We et al., 2017, p. 212). This notion is significant in the context of the study reported on in this thesis, as it suggests that breakthrough innovation is unlikely. This thesis proposes that there is indeed shared concern between teachers of different subjects, but that the concern is unknown to those who share it. That is, teachers across faculties, in this case technology and languages, are unaware of the complementary value within their disciplines, and therefore do not effectively communicate value propositions to students that could encourage reciprocal interest in those, or other disciplines. It is at this kind of intersection where disruptive innovation becomes pertinent to consider.

An angle to the above was investigated by Ketelaar et al. (2013) in a study conducted in a Dutch vocational school. Using a positivist approach, researchers surveyed 253 students to discover how teachers position themselves when a pedagogic innovation is introduced. The categories of investigation were distinct; agency, ownership, and sensemaking. The study’s focus pertained to teachers’ coaching roles in the classroom. What makes the study relevant to this research literature review is that how the teachers positioned themselves was gauged by student perceptions, and not by teacher self-perception. In the context of the study reported in this thesis, if the teachers themselves are not aware of complementary value in their disciplines (or other disciplines), it is possible that the students are, and yet have no way to express that observation. The authors report that agency, ownership and sensemaking matter, and that aspects of the ‘coaching role’ were implemented by their teachers, although “only to a strong degree” (Ketelaar et al., 2013, p. 991). That being the case, it remains difficult to generalise from these findings. Whilst the study by Srikoom et al. (2017) conceded their study was more suited to wide scale communication, it is noteworthy that Ketelaar et al. (2013, p. 1003) concede that their study “cannot be broadly generalised”. The authors suggest the reason for this is that whilst a large data set was collected, only 10 teachers participated in the study. In addition, the authors note that findings could have been significantly different had classroom observations or self-reporting been included in the study. These are useful insights considering that teachers in the study reported on in this thesis were given the choice to opt-in as participants.

2.6 Innovation and Curriculum Reform

The above resonates with the previous discussion in Chapter 1.2.3 with respect to curriculum reform. Lingard and McGregor (2014) explore a useful example of the difficulties associated with innovation and the call for curriculum reform; the New Basics curriculum. Introduced in the state of Queensland, Australia, it was trialled “between 2000 and 2003, involving 38 state government primary and secondary schools”, and “focussed on competencies and dispositions” as opposed to discipline-based approaches to curriculum construction (Lingard & McGregor, 2014, p. 1). Notably, it was a reform based on “an imagined future worker in a global context” (Lingard & McGregor, 2014, p. 2). Despite echoes of addressing ‘global context’ as with technology/STEM and languages rationale, the New Basics concept received criticism for lack of disciplinary knowledge and that this could in fact create further social disadvantage (Lingard & McGregor, 2014). In the years following the trial, Lingard and McGregor (2014) recall that the Australian education reform agenda reflected what Shalberg (2011), as cited in (Lingard & McGregor, 2014, p. 6), called the Global Education Reform Movement (GERM) which is described as a “not exclusively Anglo-American approach to school and system reform in response to globalisation”. Essentially this was a return to a standardised, test-based, market-oriented model. This example demonstrates that despite motivation to reform for wider and future purpose, and significant trial periods, the extent of potential benefit may remain unknowable.

2.7 The Role of the ‘Intercultural’ in Languages Learning

The notion of ‘intercultural’ remains a consistent theme throughout the discussion thus far. Harbon (2013, p. 78) notes that in the context of foreign language teaching, there is a shift towards “designing and implementing curricula with the aim of producing students with an intercultural competence or intercultural literacy”. Moreover, that intercultural literacy includes “the ability to take multiple perspectives, to see things from the point of view of the other, and to identify with a global shared community” (Heywood, 2007) as cited in Harbon (2013, p. 79). This resonates with a concept developed by the International Baccalaureate (IB). In a comparative study by Sriprakash et al. (2014, p. 10) researchers report on the concept of international mindedness, “which embraces an active, intercultural engagement with local and global issues and a self-reflecting awareness about other societies and customs”. The IB website states that students learn how to “demonstrate respect for themselves and others, developing international mindedness by working with others for a shared purpose and taking positive action for change” (International Baccalaureate, 2018). Intercultural competence, awareness, or literacy can therefore be seen as something not limited to languages learning, and more of a key component of a balanced and integrated (and potentially innovative) curriculum.

A small scale qualitative study by Leh et al. (2015) uses the model of intercultural communicative competence (Byram, 1997) to explore 'online intercultural exchange' in the context of pre service teachers. The study involved ten students from a university in the USA and 26 students from a university in Germany. The students were placed into small groups and required to interact via telecollaboration around a common question; "What is the importance of Diversity in Education?" (Leh et al., 2015, p. 102). After a two-week period, students from the USA then travelled to Germany allowing all participants to meet in person. Whilst only a small study, "results from both sites indicated greater comfort when initially meeting their culturally diverse peers" (Leh et al., 2015, p. 100). Citing the model by Byram (1997), researchers noted the importance of an attitude of openness and curiosity in intercultural communication which was evident in the results of the study. Despite the authors caution against drawing broad conclusions from the study, they do suggest that there are "potential benefits" in allowing "culturally diverse peers" to interact (in this case online, prior to face to face) to "provide opportunities for reflection on their cultural and linguistic learning processes" (Leh et al., 2015, p. 107). The study is not specific to technology or languages learning yet indicates the 'value' inherent in improved intercultural understanding which is shown to be a notion embedded in technology and languages rationale. The potential for this to become evident in findings in this thesis is of interest as it indicates an opportunity for exploring new value with either group of participants through linguistic or cultural experiences.

Whilst the role of intercultural competency and literacy is considered important for the study reported on in this thesis, it is important to distinguish that this study is not proposing that technology subjects should be taught in a foreign language or that languages students should study technology subjects. This is despite such programs offering the opportunity to develop intercultural skills as well as additional language skills in what has been described in some contexts (e.g. NSW, Australia) as a "crowded curriculum" (Fielding & Harbon, 2014, p. 19). For example, bilingual programs such as Content Language Integrated Learning (CLIL) could offer students the ability to combine an additional language and technology explicitly with a view to improving intercultural competency. This is supported in findings such as those by Fielding and Harbon (2014) in a 2-year multiple case study on CLIL programs in 4 NSW primary schools. The study indicated that CLIL programs produced positive responses from students, teachers, and parents, with improvements including teaching and learning strategies, thinking skills and communication. Bilingual programs such as CLIL in primary years may therefore be a valuable pre-cursor to students developing enhanced skills in communication, learning, literacy (refer Chapter 1.3), and an appreciation of intercultural factors in subject selections later in school. CLIL programs have also been broadly labelled as 'innovative' which makes them pertinent to consider in the context of education innovation.

2.8 Content Language Integrated Learning (CLIL) as Innovation

With respect to education reform, bilingual or CLIL programs could indeed be considered as "radical innovation" in ways similar to those described by (Holmlund et al., 2018, p. 3). An overview of how the 'innovation' label is used in CLIL scholarship is relevant at this juncture as it points to the far-ranging perceptions of CLIL as innovation. The purpose here is not to promote CLIL or its rationale as a solution to the questions raised in the study reported on in this thesis, nor to evaluate its effectiveness as a pedagogy. Rather, the discussion examines whether the concept of disruption as a frame of innovation becomes evident in literature describing the innovative nature of CLIL.

Bower (2020) cites broad commentary claiming that "CLIL is a movement that has gathered momentum worldwide" (p. 351) and has "developed rapidly in Europe as one means of meeting the European Commission's commitment to learning of two additional languages in addition to the mother tongue (Commission of the European Communities, 2003)" (Bower, 2020, p. 352). CLIL is described broadly as an innovation and an "alternative pedagogical approach" (Bower, 2020, p. 352). Other descriptions carry a wider description such as "an important driver for educational change" and "that CLIL equals innovative education because of its impact on the learning process itself" (Van De Craen & Surmont, 2017, pp. 22-23). Van De Craen and Surmont (2017) point to studies indicating that students in CLIL classes exhibited gains in non-CLIL mathematics classes, which further points to CLIL as "a genuine tool for educational innovation" (p. 25). This resonates with previously mentioned studies in which students from languages backgrounds other than English (LBOTE) and CLIL classes in Australia performed better in standardised literacy and numeracy testing (Cordy & Morgan, 2022; Fielding & Harbon, 2022).

Other descriptions for the innovative nature of CLIL provide further insight. The opening commentary in a study by Cañado (2018) cites several descriptions including "an unrivalled opportunity" and "catalyst for the language teaching profession" (p. 370). Cañado (2018) provides further descriptions that describe CLIL as "a real methodological revolution" (Pavón Vázquez & Rubio, 2010, p. 48) and a "catalyst for change" (Marsh et al., 2001, p. 51) in Cañado (2018). However, Cañado (2018, p. 370) raises the question of "whether CLIL is truly bringing with it such pedagogical innovation". In some contexts, CLIL is regarded more as a methodological concept (as opposed to a revolution) in which "CLIL is held to entail a thorough overhaul of the way in which language and content teaching are envisaged" (Cañado, 2018, p. 372). This review does not call into question the methodology or efficacy of CLIL and focuses more on the language used to describe the perceptions of innovation and change. Terms such as 'unrivalled opportunity', 'catalyst', 'revolution', and 'overhaul' all suggest that substantial reworking of practice is at work with a strong implication of 'innovation'. However, the 'disruptive' label does not appear.

Lopriore (2020, p. 99) reports that CLIL "experienced unprecedented success at different educational levels" and was considered an "innovative approach" when introduced in Italy in the 1990s. Although the success was not without resistance from some teachers where collaboration with content teachers caused problems. Teachers resisted as the 'curriculum innovation' raised questions about the diminishing nature of teacher roles as content and languages teachers were required to engage in a new way of working. Such resistance is unsurprising given that scholars continue to describe CLIL with powerful language. McDougald and Alvarez-Ayure (2020) suggests that CLIL pedagogy "represents a true paradigm shift" and requires "teacher training that is targeted at preparing educators to participate in making this shift a reality" (p. 156). By contrast, Dobson (2020) suggests a practical reason for the emergence of CLIL originating from policies emerging in Europe in the 1980s based simply on available time for instruction. Dobson (2020) notes that "the time available for language study could only be increased significantly by teaching other subjects through the medium of the foreign language" (Dobson, 2020, p. 509). This resonates with previous comments in the Australian context of languages operating in what has been described as a "crowded curriculum" (Fielding & Harbon, 2014, p. 19). Seen in that light, CLIL might be considered more a pragmatic approach rather than revolutionary, or as a driver of change. However, even a pragmatic approach could be described as innovative.

The above descriptions positively present the innovative nature of CLIL. Some could be described as superlative, whereas others are more muted. However, despite these descriptions, they are set in a context of continual challenge of acceptance and adoption. As recently as 2020, a study by Codó (2020) describes the "ambivalences" faced by stakeholders in a Spanish context, including "not only students, teachers, and school administrators, but also parents, and quite exceptionally, policy makers and programme implementers" (p. 2). Indeed, the argument is laid forth that the "ambivalences, rather than transient, are chronic in education" (Codó, 2020, p. 2). Ambivalences notwithstanding, a key feature commonly cited of CLIL is as a "methodological innovation" (Codó, 2020, p. 3). Moreover, that it has also been "advocated by policy makers" as an "'engine' of pedagogical reform" and "a step forward in the construction of an integrated language curriculum" (Codó, 2020, p. 3). The nature of CLIL investigated by Codó (2020) was labelled as 'experimental' and considered unique when compared to other Spanish regions. The efficacy of the program is beyond the scope of this review as the focus here is on how the approach is labelled or identified. Teachers received special training to facilitate an experimental model of CLIL with a focus on enhancing students' proficiency in a foreign language, project-based learning, and new methods for programme evaluation (Codó, 2020). The flexible nature of the programme is described as having been a motivating factor for teachers in that it "gave them [and managerial staff] the freedom to adapt CLIL to their specific social and pedagogical context" (Codó, 2020, p. 13). A conclusion drawn from this was that there was "no official blueprint for CLIL implementation" (Codó, 2020) and that stakeholders

were enabled to respond appropriately to their immediate situation. This resonates with statements made by Coyle (2013) in the context of a prior study conducted in England and Scotland. Hybridity is offered as a key component with both advantages and disadvantages, which suggests that "there are no fixed models which pre-determine how CLIL will develop" (Coyle, 2013, p. 245).

Whilst specific references to 'disruptive' innovation do not appear in the literature, there is broad agreement that CLIL is 'innovative'. However, as this thesis proposes, a dilemma remains with languages learning. At this juncture, the Codó (2020) study introduces noteworthy language which offers an opportunity for further investigation into the nature of 'innovation' that identifies new value and addresses the research questions posed in this thesis; for both languages and technology. The notions of 'experimental', 'flexible', and 'freedom to adapt' open a small window to consider a type of innovation which may at first seem counterintuitive. These notions are not exclusive to CLIL; however they are noted in this context. The descriptions for innovation thus far have built the narrative of improving 'upon' previous approaches. However, not all innovations necessarily build upon the current trajectory of improvement. In some cases, new value is found by changing the expectation of what constitutes improvement for the sake of future gain. Disruptive innovation is such an approach.

2.9 Disruptive Innovation

The study reported on in this thesis focuses on how technology and languages students conceptualise their subjects and what value propositions offered by the subjects motivated the students to select them. The subjects are set in the context of a dilemma of calls for greater student participation and performance in those subjects and the challenges faced by schools to allocate staff and resources to them. The introductory discussion and literature review thus far illustrate that there have been constant efforts to reform and improve technology and languages education through policy and practice in recent decades, however the dilemma remains. Indeed, innovation is needed. To address the dilemma with a view to uncovering new value for students and schools alike, this study draws on the frame of disruptive innovation.

Disruption enables the study to pursue a counterintuitive line of discussion in analysis of findings by giving voice to student conceptualisation in the search for lesser known or understood value propositions. An overview of the disruptive innovation theory is presented here, followed by examples of attempts to use the disruptive frame in education contexts in Chapter 2.9 and 2.10. The conceptual frame used for discussion is then outlined in Chapter 2.11.

Disruptive innovation theory is credited to the research conducted by Clayton M. Christensen which is widely known through the publication of the book, *The Innovator's Dilemma: When New Technologies Cause Great Firms to Fail* (Christensen, 2013). The book states that it "is about the failure of companies to stay atop their industries when they confront certain types of market and technological change" (Christensen, 2013, p. ix). The choice of disruptive innovation for this study is based on the notion that disruption is not simply a call for 'new' or 'better' or a call for 'innovation'. Based on the discussion of literature thus far, it is likely that such an approach would result in lacklustre reception.

Disruption is chosen in this current doctoral study because it accepts that failure can happen. It is acknowledged that disruptive innovation research originated from the study of companies, however the theory has been applied to many sectors including education (Christensen et al., 2010). As noted in Chapter 1.0 Introduction, this current doctoral study draws a parallel between firms and education with respect to the dilemma stated above. With respect to 'failure', Christensen (2013, p. ix) states that "it's not about the failure of simply any company, but of good companies – the kinds that many managers have admired and tried to emulate, the companies known for their abilities to innovate and execute". As previously stated, failure in this research context is seen as the low participation and performance in recognised areas of need caused by the focus on resource allocation to popular mainstream subjects (Marginson et al., 2013). In choosing the disruptive frame, the study in this thesis acknowledges and does not denigrate past innovative approaches to education. Rather, it recognises the constant challenges faced and the continual commitment required to address them.

As the preceding discussion has shown, education is also subject to 'market and technological' factors which provides room to consider disruption in the education context. Christensen et al. (2010) provides the following overarching statement, which is helpful in the context of this thesis,

> The disruptive innovation theory explains why organisations struggle with certain kinds of innovation and how organisations can predictably succeed in innovation. (Christensen et al., 2010, p. 44)

As will become evident in the next section (Chapter 2.9), there are many examples of how education institutions have struggled with innovation that has been labelled as disruptive. This thesis contends that the struggle lies mainly with recognising that not all innovations necessarily improve the current trajectory of improvement. At times, a different value proposition is required to uncover opportunities for new value. Christensen et al. (2010, p. 47) states that "instead of sustaining the traditional improvement trajectory in the established plane of competition, [a disruptive innovation] disrupts that trajectory by bringing to the market a product or service that actually is not as good as what companies historically had been selling". Typically, the

innovation is sold into a market of nonconsumption, whereby consumers who could not afford existing product offerings now had an alternative to no products at all. An example commonly cited is ‘online learning’ whereby virtual classes are considered ‘not as good’ as traditional face to face classes, but better than no classes at all. The online learning narrative could be seen as ‘disrupting’ the notion that technological improvements in education should somehow offer a solution to underserviced students *and* maintain or improve upon a trajectory of improvement. However, this concept also faces challenges as the following discussion will illustrate.

For a product or service, Christensen et al. (2010) provides a helpful description of the development of a disruptive innovation.

> Success with disruptive innovations always originates at the simplest end of the market, typically competing against nonconsumption. Then, from that base, the technology gets better and better until, ultimately, it performs well enough that it supplants the prior approach.
> (Christensen et al., 2010, p. 85)

The above statement provides a useful foundation for disruption as a frame used in the study reported on in this thesis. It is not suggested that a ‘disruptive technology’ can be plugged into the stated dilemma to provide a fix for participation, performance and resource allocation in technology and languages learning. However, insight can be drawn from the notion of beginning at the ‘simplest end of the market’. This research study leans on that notion by examining the conceptualisations of technology and languages students (the market) without any assessment of correctness of their understanding of the subjects. Participants express their conceptualisation of their subjects as they see it from their own perspectives and from their lived experience of the subjects. The participants are not in an environment of nonconsumption, as they are in classes in school. However, the numbers are low and under pressure and the environment could therefore be considered as ‘low consumption’. How the value identified in conceptualisation could be leveraged is then considered as a potential pathway to ‘supplant the prior approach’ towards innovation in developing participation in the subjects. The position assumed in the use of the frame therefore takes shape in ‘disruptive thinking’ for strategy, rather than developing a disruptive product or service.

To operationalise this frame in the study, the five principles that underpin disruptive innovation theory as described by Christensen (2013) are paralleled to the research context. These parallels are created to contribute to the basis for discussing findings.

> **Principle No. 1: Companies Depend on Customers and Investors for Resources**
> While managers think they control the flow of resources in their firms, in the end it is really customers and investors who dictate how money will be spent because

companies with investment patterns that don't satisfy their customers and investors don't survive.
(Christensen, 2013, p. xix)

Research Parallel No. 1: Schools and subjects offered within them depend on students for funding and survival.

Principle No. 2: Small Markets Don't Solve the Growth Needs of Large Companies
The larger and more successful an organisation becomes, the weaker the argument that emerging markets can remain useful engines for growth.
(Christensen, 2013, p. xxi)

Research Parallel No. 2: As mainstream subjects become more popular, the weaker the argument for funding and resourcing subjects of lower participation.

Principle No. 3: Markets that Don't Exist Can't Be Analysed
Companies whose investment processes demand quantification of market sizes and financial returns before they can enter a market get paralysed or make serious mistakes when faced with disruptive technologies.
(Christensen, 2013, p. xxii)

Research Parallel No.3: Schools that demand quantification of viable class sizes before resources and staff are allocated are unable to service the needs of student cohorts of low or unpredictable numbers.

Principle No. 4: An Organisation's Capabilities Define Its Disabilities
The values and processes of an organisation that cause employees to prioritise projects to develop high-margin products, cannot simultaneously accord priority to low-margin products. The very processes and values that constitute an organisation's capabilities in one context, define its disabilities in another context.
(Christensen, 2013, p. xxii)

Research Parallel: Schools that allocate resources to high-demand subjects are less capable of allocating resources to low-demand subjects.

Principle No. 5: Technology Supply May Not Meet Market Demand
Disruptive technologies, though they initially can only be used in small markets remote from the mainstream, are disruptive because they subsequently can become fully performance-competitive within the mainstream market against established products.
(Christensen, 2013, p. xxiii)

Research Parallel: Low-demand subjects become disruptive (create a dilemma) if demand subsequently grows, creating challenges with reallocating resources away from previously higher demand subjects.

As previously stated, other studies have cited ‘disruption’ as a theory contributing to analysis. However, the uses are varied in their application ranging from cursory to intentional, with some applications leading to what could be described as a mislabelling of the theory. Examples of these use cases are discussed prior to outlining a conceptual frame which combines student conceptualisation with disruptive theory for discussion of findings in this study.

2.10 Interpretations of Disruptive Innovation in Education

To build towards a frame for discussing findings in this study, the following provides a broader exploration of interpretations and perspectives on disruptive innovation with examples from secondary and higher education. This is important to establish, for as disruption is widely recognised and discussed, it is not necessarily always implemented in the manner that Christensen (2013) describes. The examples discussed identify where the disruptive label is used but is poorly followed through or incorrectly assigned. In some cases, disruptive innovation is contrasted with or mistaken with other concepts such as invention. The discussion also investigates the influence of public policy, or political factors that impact the understanding of disruption. This can affect both how existing schools are influenced by such policy, and how new schools, or concepts for new schools are developed and established. There are few examples in the literature of where disruption is used in the original sense as described by Christensen (2013) for secondary schools. That is, in a truly commercial sense. Yet there are examples of where what could be described as ‘disruptive thinking’, or at least approaches to teaching and learning that are influenced by concepts of ‘disruption’ exist. The higher education sector provides noteworthy examples. Moreover, there are also examples of where attempts to disrupt closely match the application to education as described by Christensen, Horn and Johnson (2011) in their extensions of the original concept. This examination therefore provides a useful basis for analysing the data recorded in this doctoral study using the disruptive lens.

Overwhelmingly, the introduction of information and communication technology (hereafter ICT) features prominently in descriptions of educational innovation. From the European perspective, Bocconi et al. (2013) cite extant research claiming the importance of educational innovation and the need to improve teacher education for economic prosperity. ICT is labelled as a “key enabler of innovation in Education and Training (E&T) and for learning in general” (Bocconi et al., 2013, p. 113). The authors describe how definitions for innovation vary widely, and outline a selection of approaches that help inform the discussion in this thesis. Bocconi et al. (2013, p.

114) cite the Organisation for Economic Cooperation and Development, Centre for Educational Research and Innovation (hereafter OECD/ CERI) which defines innovation as “any dynamic change intended to add value to the educational process and resulting in measurable outcomes, be that in terms of stakeholders satisfaction or educational performance”. Whilst not specifically referencing disruption, the definition contributes to this discussion because of the inclusion of the concept of ‘adding value’. As previously discussed, the perception of value, or value proposition plays a key role when considering a disruptive path. In the study reported on in this thesis, what factors influence value perception in subject selection is a key focus question in data collection. In the context of Education and Training, the authors highlight the complementary roles of effective training and the development and implementation of innovation. One helps to drive the other. Bocconi et al. (2013, p. 115) describe ICT as an innovation offering “profoundly new ways of using and creating information and knowledge” as opposed to simply improving upon existing methods. In addition to other descriptions cited, the authors highlight the work of Cooper (1998) who presents a “multidimensional model of innovation for thinking about and evaluating the relationship between organisational characteristics and the adoption of innovation” in Bocconi et al. (2013, p. 116). According to the model, innovation must be considered in terms of the following dimensions:

- Product – process
- Radical – incremental
- Technological – administrative

(Bocconi et al., 2013, p. 116)

These dimensions resonate with the four types of innovation considered important by the OECD/CERI noted by We et al. (2017) (in Chapter 2.5). In the OECD/CERI analysis, process innovations are identified as producing significantly improved pedagogies. However, the dimensions presented by Cooper (1998) add to the previous analysis. They are relevant in an educational context and provide a window into disruption through the distinction between radical and incremental (vis-à-vis disruptive and sustaining). Further still, Renzulli (2005) in Bocconi et al. (2013, p. 114) adds to the granularity by suggesting that “innovation is about change (incremental, radical or disruptive) and implies a certain degree of novelty”. ‘Radical’ and ‘incremental’ are tenets of disruptive innovation. Cooper does not label them as such, whereas Renzulli includes radical with disruptive. Noteworthy is that the paper by Bocconi et al. (2013) does not reference the work by Christensen (2013), yet makes the following claim:

> In order to bring about transformative changes to education, the role of ICT should be *disruptive* [original in italics], changing both the teacher’s and the learner’s role in formal settings. Furthermore, for an innovation to endure and thrive, pedagogical innovation must be accompanied by changes at the institutional level and beyond in values, practices, and infrastructure.
> (Bocconi et al., 2013, p. 116)

The three different perspectives discussed here provide an insight into the variance of how disruption is understood and labelled. Despite not clarifying the definitions of disruption, Bocconi et al. (2013) state that the role of ICT *should* be disruptive. Also noteworthy in the above statement is the inclusion of 'values', both at the institutional level and beyond. The authors do not state the boundaries of 'beyond', however it is reasonable to surmise that personal, or at least 'personnel' values are implied. This level of granularity is pertinent, as the unit of investigation in this current doctoral study is the individual.

On a large scale, the higher education sector has experimented extensively with exploiting the benefits of widescale use of ICT as a form of innovation. Massive Open Online Courses (hereafter MOOCS) enable universities to offer courses online without the need for expensive campus infrastructure, at a lower cost to a larger (potentially limitless) cohort of students, located anywhere in the world where an internet connection is available. This experience for students could be argued as 'not yet good enough', that is, not as good as a full-service, on-campus university experience. But for those students who simply cannot afford to attend a university for reasons such as cost, geographical access or even entrance score, MOOCs offer a solution. When the alternative to a full-service university experience is 'no experience', MOOCs offer an option for consumption, as opposed to 'no consumption'. In a 2018 conceptual analysis of MOOCs as a disruptive innovation, Al-Imarah and Shields (2019) agree that on face value, MOOCs appear disruptive and identify with the criteria established by Christensen et al. (2015). However, their deeper analysis shows that implementation of MOOCs is not necessarily disruptive.

To provide a framework for analysis Al-Imarah and Shields (2019, p. 258) apply three characteristics of disruption to MOOCs: "performance, benefits and market". The authors note that the concept of higher education as a market is criticised due to barriers to entry; "public interest and necessary government controls [which] render a market inherently impossible" (Marginson, 2013) in Al-Imarah and Shields (2019, p. 261). Debate of higher education as a market notwithstanding, Al-Imarah and Shields (2019) recall an important distinction made by Christensen (2017) whereby disruption is,

> a process by which a product or service takes root initially in simple applications at the bottom of a market and then relentlessly moves up market, eventually displacing established competitors.
> (Christensen, 2017, para. 1)

A consequence of this distinction is that MOOCs have the potential to or should eventually cannibalise existing full-service university courses. Al-Imarah and Shields (2019) cite research that speculates about this possibility but state that the evidence for this remains limited. In this

context, their focus turns to performance and benefits. They note that Christensen, Horn, Caldera, et al. (2011) refer to online learning as a technology driver that can improve performance and benefits through lower cost offerings which “improve efficiency and increase revenues”, in Al-Imarah and Shields (2019, p. 261). However conclusions drawn by Bocconi et al. (2013) in the above discussion would caution face value acceptance of such statements. Merely making online education available or providing students with computers is considered by some as not enough. In the development of a European framework for 1:1 computing for secondary students, Bocconi et al. (2013) make the distinction between 1:1 computing and 1:1 learning. This resonates with criticism of online learning in higher education by de Langen and van den Bosch (2013) in Al-Imarah and Shields (2019), who claim that MOOCs cannot replace (or displace) individualised tutoring. Instead, de Langen and van den Bosch (2013) argue that MOOCs may in fact be more *disturbing* than they are *disruptive*.

Efficiency and increased revenues are indeed positive outcomes; however, they are offset by problems with participation and performance. Typically, disruptive innovations initially underperform relative to existing products or markets and then move upward. Al-Imarah and Shields (2019) claim that whilst popular, MOOCs have been shown to struggle in achieving performance characteristics in that their completion rates are low (Burd et al., 2015), and that their ability to increasingly attract new customers (students) is limited. They conclude that their analysis “shows some correspondence between the features of MOOCs and the defining criteria of disruptive innovation, but it [also] shows many more areas in which MOOCs do not align to these criteria” (Al-Imarah & Shields, 2019, p. 264).

Liu (2013, p. 2) claims that initial teacher schools are “ripe for disruption” given “their high costs and stranglehold on the teacher-preparation market” and that “online learning is poised to offer the mix of cost and quality required”. Two examples are given which provide a helpful contrast to the preceding discussion about the disruptive qualities of MOOCs.

- The University of Southern California – MAT@USC, an online course within a traditional research-based university.
- Western Governors University – non-profit, fully online.

The USC Master of Arts in Teaching (MAT@USC) offering presents an example of a course that was developed at significant cost and effort for online delivery. It leverages the methods and technologies that have become synonymous with online learning: webinars, web-based lectures, archived lecture videos, online study groups, a student-social networking platform and extensive use of mobile computing devices (Liu, 2013). Practicum takes place close to where the student lives with local supervision. Noteworthy is that the course is pitched as a disruptive innovation, yet certain characteristics of the course leave this description open to debate. Liu (2013, p. 3) explains that the course is delivered alongside the traditional course, and that the content is the same albeit “optimised to fit the new delivery method”. Moreover, the course was

designed not to displace the traditional course but provide the capacity to "grow its overall enrolment without the constraints imposed by the brick-and-mortar model" (Liu, 2013, p. 2). The approach has been successful according to that metric; students in the online program represent a different 'customer' to those in the traditional program largely by geographical location and life circumstances. However, the course falls short of a 'disruptive' innovation in one key category. Despite the economies of scale, as seen with MOOCs, the MAT@USC costs the same as the traditional face to face course. Therefore, it does not provide the opportunity for prospective students who are currently 'not consuming' to enter the market at lower cost with a degree which is 'not as good as' a traditional degree. In that sense, the USC offering is more like an enhancement to an existing product, with lower cost of production which simply scales up the product in terms of revenue and cost efficiencies. From a commercial perspective this is very appealing. From the students' perspective, it offers simpler access with some conveniences. Yet it fails the students on price. As such, there are disruptive elements to the MAT@USC course, however the course is more closely aligned with 'sustaining' innovation.

The teacher preparation course at Western Governors University presents a compelling alternative to MAT@USC. As a fully online course with no physical campus, the course relies on the previously assumed technologies synonymous with online learning. However the course does not replicate a traditional course, neither in structure nor methods of progression. Liu (2013) explains that

> Students pass a course as soon as they can demonstrate proficiency as measured by rigorous testing requirements delivered via an advanced assessment system. The assessment for each competency uses multiple formats, including traditional testing, portfolio assignments, and observations.
> (Liu, 2013, p. 4)

This is a massive shift in perception with respect to what constitutes a competent graduate and offers talented students a real option for fast-tracking their careers. What makes this shift so significant is that it represents a reliance on alternative thinking about how the students learn and progress, rather than simply applying technologies to an online learning environment. Also significant is that "WGU's program is modular, so it can separate content delivery from the practicum" (Liu, 2013, p. 4). This de-coupling or unbundling of the 'product' (in this case, subject structure) provides even greater flexibility for students as they navigate through course requirements. Anderson and McGreal (2012) have also posited that unbundling of higher education services could pave the way for cost benefits, particularly for online institutions. They state that the complexity of the university system and the "multifaceted nature of the services and costs centres…provide the context for the possibility of disaggregation and removal or outsourcing of selected component pieces" (Anderson & McGreal, 2012, p. 381). It is unknown as to whether the WGU approach is guided by this principle, although strong parallels are

evident. A key aspect where unbundling has made a striking difference is cost. And not only the dollar figure, but the way students can put their fees to work. Students pay a flat fee per 6-month term which covers them for as much coursework as they can complete within that term. At the time of writing, the graduate program fee in the Teachers College is $3490 USD per term (plus nominal resource and program fees), which includes supervised field experience (Western Governors University, 2021). The combination of a flat fee for a given period, with the ability to complete as many subjects as possible based on competence rather than credit accumulation presents a unique value proposition for students. This is in stark contrast to the MAT@USC. Course fees vary by program. However, at the time of writing, the USC website states that MAT courses can be completed within 12 months, although a typical sample program is provided consisting of 25 units over 3 semesters (University of Southern California, 2021a). The cost for a typical path is priced on a unit basis of $2035 USD (University of Southern California, 2021b). Making a like-for-like total price comparison in this case is difficult because the WGU structure allows students to complete courses quickly at a flat rate. However, the cost advantages are clearly in favour at WGU. Critics may call into question the quality of education offered at these price points, however a deeper exploration into cost vs. quality in this example is beyond the scope of this literature review.

The above examples describe a high-level view of approaches to innovation in higher education with an attempt towards disruptive innovation. To provide a deeper view of teachers' experience in innovative contexts, Ramsey and Khan (2020) report on a New Zealand based study, in which the

> research aimed at understanding the challenges that innovation presents to teachers in higher education, using dilemmas as a method for uncovering the nature of tensions through which successful educational innovators need to navigate.
> (Ramsey and Khan, 2020, p. 2)

The research contributes to this discussion as it provides a lower-level insight into the actual experiences of teachers and frames it in the context of 'dilemmas'. In Chapter 1.0 Introduction it was stated that dilemmas may be experienced by secondary school administrators as they grapple with where to allocate resources given disparate subjects in diminishing demand but high perceived need. Ramsey and Khan (2020) describe a dilemma in terms of opportunity cost. That is, two propositions are faced, yet only one can be pursued at the expense of the other. Or in the case of schools, subjects with low student numbers may continue to be offered but with limited resources and low perception of viability. Ramsey and Khan (2020) suggest that culture is a common element in determining why such situations continue to exist. They posit that,

> culture can be thought of as the pattern of dilemma resolution that distinguishes one community from another. Over time, the choice of one proposition over another by

> members of a community becomes an embedded assumption about the right way to do things.
> (Ramsey and Khan, 2020, p. 3)

The study used a qualitative approach with semi-structured interviews “to explore participants’ experiences and understanding about dilemmas they encountered at various relevant stages of innovation: conception, team development, innovation development and achieving sustainability” (Ramsey & Khan, 2020, p. 4). The research does not specifically target disruptive innovation, although the researchers have some knowledge of the concept as they reference the work of Christensen, Horn and Johnson (2011). However, they do not discuss ‘disruption’ in terms of simpler, less expensive products that target non-consuming customers. Instead, they simply state that “innovation is often disruptive” and that “innovations were potentially disruptive to their colleagues” (Ramsey & Khan, 2020, p. 7). This provides an example of how the label of disruption is poorly aligned with perceptions of innovation. That said, the study does raise important findings. The researchers used thematic analysis to examine the interview data and uncovered four themes: empathy for students, perseverance and resilience, love and hate responses, selling and diffusing innovation.

The theme which aligned closest with the original concept of disruptive innovation was selling and diffusing innovation. The process used by participants was simple: operate alone, start small, test the idea, if successful grow and expand. Only when evidence of success appeared did participants try to encourage others to adopt their ideas. The resemblance to disruptive innovation in this case is that the innovations (or new ideas) started small and were developed based on feedback and success. They were not broad-scale or implemented through management via a top-down approach. Ramsey and Khan (2020) then describe another key element in the disruptive process which often leads to failure.

> Consequently, growth involved ‘selling’ the concept to various stakeholders, including potential adopters and executives who provided resources and opportunities.
> (Ramsey & Khan, 2020, p. 7)

Failure to scale an innovation often occurs at this point when higher level managers cannot measure or predict the future success of an idea based on incumbent approaches and metrics for success (Christensen, 2013). In the case of the Ramsey and Khan (2020) study, participants noted that high levels of persuasion, and even evasion were required for their ideas to gain traction. Responses also indicated high levels of emotional investment. The following responses provide insight.

> *We had to be very diplomatic and persuasive with the senior colleagues of the faculty.*

> *The nature of innovation is that it should be kept secret until it happens. If I go and describe what I want to do, the people around me would say things like "that would be difficult" …And I would get depressed after talking to those people*.
> (Ramsey & Khan, 2020, p. 7)

The significance of this example is that innovation was investigated and described as being disruptive in some respects, yet it was not analysed using a truly disruptive lens. Therefore, the report potentially mislabels the notion of disruption as improvement (or a sustaining innovation). The report also highlights that innovation in that case was difficult on a personal level, resulting in personal emotional reactions.

The small-scale higher education study by Ramsey and Khan (2020) illustrates that despite difficulty, innovators often persist. This resonates with a large-scale analysis of examples from secondary education in the United Kingdom (UK). The focus is on successful innovations across school systems. Aptly titled "Innovation is possible, it's just not easy", Greany (2018, p. 65) highlights "that system-wide change is possible, but requires strong and sustained political support and capacity building within a values-based framework that allows for local agency and adaptation". Extant research on the general notion of 'improvement' is cited against a background of lacklustre change, despite significant effort. The major weaknesses identified are the metrics applied to measure success: tests and exams. Underlying the system-wide innovation described, are characteristics of high accountability, autonomy and "lateral networks as the basis for a 'self-improving' school-led system'" (Greany, 2018, p. 69), built upon several decades of government reform. Put simply, schools are empowered to self-improve with little government intervention.

The significance of the analysis by Greany (2018) for this review, is the way in which disruption is referred to in the context of innovation. Four case studies of improvement in four UK schools are discussed. A four-box framework developed by Leadbeater and Wong (2010) in Greany (2018, p. 74) is applied for analysing the innovations across four dimensions: "formal versus informal learning and sustaining versus disruptive innovation". Of interest here is the metalanguage used for sustaining and disruptive innovations. Words to define sustaining innovations include 'improve' and 'supplement', which fit the general nature of sustaining innovations. Good products are made better. However, words to define disruptive include 'reinvent' or 'transform'.

The Greany (2018) study investigated schools across the whole system, and an in-depth review of findings is beyond the scope of this review. However, the high-level findings are pertinent. These include that schools classified as implementing disruptive innovation strategies incorporated formal learning, informal learning, and both sustaining and disruptive innovations. These schools were also classed as having less tightly structured curricula, with significant

funding provided for the promotion and support of the school's approach. The authors of the study concede that the categorisation and analysis were "not meant to be scientific" since the "examples are too disparate and the evidence base underpinning them too variable to be able to make a robust assessment of 'what works' in innovation" (Greany, 2018, p. 77). This is likely due to the size of the study. Yet further to the high-level findings mentioned above, the authors highlight three additional key themes. For brevity, these are that (1) "asking teachers to change their practice in significant ways is risky and demanding", (2) "that increasing school autonomy and inter-school competition will automatically lead to systemic innovation appears to be flawed" and that (3) large scale change requires "strong and sustained political support" (Greany, 2018, pp. 77-78). The first of these resonates with the study by Ramsey and Khan (2020) who reported that ideas needed to be tested before being shared with colleagues, and that the likelihood of rejection was high. That is, change was risky. Greany (2018) also concludes that the perception of the importance, value and legitimacy of innovation are raised. This conclusion is relevant to the study in this thesis since 'value' could play a key role in understanding why students select subjects that might be considered less popular, or fringe subjects. Whether and how the students perceive that value as a potentially innovative edge to their studies will be considered.

The discussion thus far provides insight into varied interpretations of innovation in education contexts. At this point, the closest implementation of a 'disruptive' education innovation is evident in the initial teacher education program at Western Governors University. Although large scale, and at tertiary level, it demonstrates a model in which students can choose a solution that is more convenient and costs less, but arguably 'not as good' as a full service, on campus experience. It is a deliberate choice against the mainstream, yet still considered valuable enough to pursue. In the context of this study, technology and languages are identified as subjects at the heart of a dilemma. Despite low participation rates and resourcing constraints, students elect to study them. This is also a choice against the mainstream and driven by a perception of value. This study aims to understand the value perception held by these students as a means to addressing the dilemma. Using the framework of disruptive innovation provides insight into how customers (or in this case, students) perceive that value. The discussion therefore continues with further investigation of examples where innovations in education are described as unique, radical, breakthrough, disruptive, or perhaps mis-described as disruptive.

A study by Kafai et al. (2014) provides a good example of the complexity of how 'disruption' is considered in educational innovation. It is of particular relevance to the study reported on in this thesis as it investigates the combination of disparate subject domains, in this case e-textiles and computing technology. E-textiles is an emerging part of the 'maker movement' whereby textiles are combined with electronics and computing "by integrating the use of "soft" textile materials that are sewn and embroidered with conductive thread" Kafai et al. (2014, p. 533). The study by Kafai et al. (2014, p. 532) uses the disruptive moniker to "examine the role of e-textiles as both

an opportunity for, and challenge in, breaking down traditional barriers to computing". The authors reference the work of Christensen et al. (2010) and state that the "concept of disruption is typically associated with promoting school reform" (Kafai et al., 2014, p. 535). The focus then switches to what they describe as their "critical themes – promoting transparency, integrating aesthetics, and increasing diversity in learning with e-textiles" (Kafai et al., 2014, p. 535). Moreover, they state that these three themes "serve to disrupt typical notions about how and who can and should learn and create with computers" Kafai et al. (2014, p. 535). By referring to 'who', the study questions the role of gender across these subject domains, and uses the themes as a lens to support "new visions for participation across traditionally gendered boundaries" (Kafai et al., 2014, p. 536). The study casts into question the acceptance that computing technology is a male dominated domain, and that textiles technology is more commonly associated with females.

In the context of this review, a strength of the study by Kafai et al. (2014) is that it targeted a similar school age group (age 14-15) and number of participants (n=35) to the current doctoral study. Demographic diversity included "23 percent African American, 29 percent Caucasian, 14 percent Asian, and 17 percent mixed race/ethnicity" (Kafai et al., 2014, p. 539). Gender mix was relatively even (boys n=20, girls n=15). Students took part in workshops in which they designed and made e-textiles projects of increasing complexity. Artefacts produced by the students were analysed in accordance with the abovementioned themes of transparency of computing technology (understanding component parts), integrating aesthetics into learning, and diversity (gender). In broad terms, the study aimed to uncover whether the combination of the computing technology and e-textiles domains could develop increased reciprocal interest in the other domain (a similar theme to the current doctoral study). The study revealed that there was some adjustment in the students' perceptions, but that this was experienced more so by the girls who began to develop "new identities as "techies"" (Kafai et al., 2014, p. 552). A weakness of the study is that it fails to identify clear links between the research intent and the references to disruption. Despite referencing the work by Christensen et al. (2010), further use of the word disruption refers mainly to changing or altering students' perceptions. The study clearly states that it is investigating seemingly disparate domains of crafting, engineering and computing, and designing with e-textiles. This is very similar to the intent of studying what can also be described as the seemingly disparate domains of technology and languages. However the study by Kafai et al. (2014) does not ask the question of why students would elect subjects that are not considered mainstream or of potentially lesser value, as the subjects investigated are not presented that way. Instead, the authors claim that one of the key arguments of the study "is that e-textiles can help increase the participation of historically marginalised groups – particularly girls and women – in computing" (Kafai et al., 2014, p. 551) and "foreground important questions about who is involved in making and what is being made" (p. 550). Whilst 'disruption' is considered as a frame for the study, greater emphasis is placed on the three themes of transparency, aesthetics, and diversity. The Kafai et al. (2014) study therefore

resonates strongly with the intent of the study in this thesis. It clearly seeks to encourage an alternate perception to initiate change. However, it is arguable as to whether Kafai et al. (2014) used ‘disruption’ to underpin their intent in the way that Christensen et al. (2010) originally theorised. As de Langen and van den Bosch (2013) noted, such approaches may also be considered more ‘disturbing’ than disruptive.

Conole et al. (2008) present a paper which headlines ‘disruptive technologies’ alongside ‘pedagogical innovation’. The paper contributes to this review as it reports on case study findings within a higher education context including Medicine and Computer sciences, and also Languages, Linguistics and Area Studies. The case studies investigate “learner stories” about students’ “experiences of e-learning” (Conole et al., 2008, p. 512). They are not concerned with reciprocal interest in the subject areas, or the perception of value in those subject areas. However, the paper provides insight into how ‘disruption’ continues to appear in the education innovation narrative.

Conole et al. (2008) open with the statement that “technologies have long been promoted as ‘disruptive technologies’” (Sharples, 2002) in Conole et al. (2008, p. 511). For the remainder of the paper, no further reference is made to ‘disruption’, with the exception that communication technologies that students used were at times disruptive, i.e., interrupted their study. To identify where Conole et al. (2008) locate their notion of disruption, it is helpful to refer to Sharples (2002). Referring also to an e-learning context, Sharples (2002) frames mobile technologies as a concept that can “disrupt the carefully managed environment of the classroom” (p. 504). The paper seeks to side-step the practical aspects of using technologies in instructional design and classroom management and rather “examine an alternative approach to computer-aided learning, based on personal wireless networked technologies” (Sharples, 2002, p. 505). At the time of writing this review, the findings reported may seem redundant given the rate of change in mobile technology since 2002. Of note, the author does not reference any work by Christensen, despite publishing the paper only a few years after Christensen published the original work which popularised the theory (Christensen, 2013). References to ‘disruption’ also appear unsupported in terms of the source of the concept. However, there are echoes of disruption as Christensen (2013) describes it. In outlining the context of the research, Sharples (2002) states that,

> A dilemma at the heart of networked learning is that learners can command an increasingly sophisticated set of communication and computing devices, which they are forbidden to use within formal education because they disrupt lessons and lectures. Meanwhile, schools, colleges and universities are starved of IT resources, and in many cases are failing to make best use of those resources they have.
> (Sharples, 2002, p. 506)

Despite the dated nature of the technology being discussed, the identification of a dilemma is consistent with a discussion on innovation in the disruptive context (Christensen, 2013). The above dilemma resonates with the dilemma investigated in this research study in that students are making choices that present challenges to school administrators around resourcing. Whilst the dilemma may have been clear and present at the time, the argument by Sharples (2002) is diluted by the unsupported reference to, or casual use of the disruptive frame. It is noteworthy that Conole et al. (2008) have continued with this diluted reference, although findings in that paper do contribute to this review.

A detailed discussion on the findings presented by Conole et al. (2008) is beyond the scope of this literature review. However, the concluding statements about students' e-learning experiences shed light on the complexity of using the disruptive label in the context of this review. Competing value propositions, or decisions to deliberately choose a lesser quality technology option when better quality options were out of reach were not explored. The authors clearly state, "our intention was to follow students who showed a lot of experience in using technology to support their learning" (Conole et al., 2008, p. 513). Findings were based on how students added technologies to their learning to enhance or improve their learning trajectory. A focus on 'adding' technologies rather than substituting suggests a sustaining approach from the outset. Eight factors were found that influenced students' use of technology in their learning.

1. Pervasive
2. Personalised
3. Niche, adaptive
4. Organised
5. Transferable
6. Time and space boundaries
7. Changing work patterns
8. Integrated

Of these eight factors, three begin to approach a disruptive definition: time and space boundaries, changing work patterns, integrated.

With respect to time and space boundaries Conole et al. (2008) found that "students are now able to communicate with tutors and peers in a variety of ways and are coming to expect immediate or near-immediate responses" (p. 522). This suggests that the traditional context of learner and tutor in the same space is breaking down, and that students increasingly value an electronic response in the same way as an in-person response. The speed of response is also noteworthy, indicating that speed had become an important factor, and that a virtual, or electronic response was considered good enough if the response was quick. Changing work patterns were identified in the manner by which students "gather, use, and create knowledge as well as their perception of the value and worth of information" (Conole et al., 2008, p. 522).

There is no indication that e-learning was a substitute for the dissemination, collation, and creation of knowledge, however the e-learning experience did raise the question of value for students.

The resultant change in work patterns suggests that there was enough value to invest effort in making the changes. It is not clear from the findings as to whether this was considered more or less valuable than physical in-class knowledge acquisition. However, the third factor, integration, raises an important aspect of disruption: modularity. Findings indicated that the integrated nature of e-learning technologies enabled students to use “tools in a combination of ways to suit individual needs” with “evidence of mixing and matching” (Conole et al., 2008, p. 522). Rather than be limited to a physical learning environment, e-learning technologies provided students “with more flexibility in terms of being able to undertake learning anytime, anywhere” (p. 522). When considered together, these three factors indicate that students found new value by using e-learning technologies. Their perception of what was good enough began to change, and the technologies allowed them to seek new and individualised pathways to achieving their learning objectives. The findings fall short of identifying whether students had to accept a lower perception of value first, in order to achieve higher or an equivalent standard of learning outcomes. The authors conclude that “students are using technologies to support all aspects of their learning” and that “technology is not simply seen as an ‘add on’ for these students” (Conole et al., 2008, p. 522). Moreover, that “students are using a range of different types of e-learning strategies, appropriating the tools to meet their own needs” (p. 522).

The authors make no concluding reference as to whether the e-learning technologies they investigated are indeed disruptive, despite introducing the study with the claim that “technologies have long been promoted as ‘disruptive technologies’” (Conole et al., 2008, p. 511). In the context of this literature review, the intent is not to question the validity of the findings. It is to exemplify the range in which ‘disruption’ is used as a frame for investigating innovation in an education context. Based on the concluding statements above, e-learning technologies did offer students innovative approaches to learning. However, they are more consistent with sustaining innovations, rather than disruptive innovations.

In contrast to Conole et al. (2008), a study by Nowell (2014) investigates the use of ‘disruptive technologies’ based on clearer reference to disruption as defined by Christensen (2013). Nowell cites Norris and Soloway (2009) who compare the linear nature of technological change (Rogers, 1995) with the nonlinear nature of technological change proposed by Christensen (2013) and Moore (2014). Norris and Soloway (2009) describe the rapid pace of adoption of cell phones in schools in the United States of America (USA), and the dilemma created by schools banning or restricting their use. Demand factors driven by students, parents and administrators, as well as cultural and social factors place pressure on schools which need to ensure equitable resource allocation amongst students (Norris & Soloway, 2009). The ‘disruption’ emerges as

students are willing to accept a smaller handheld device when a larger, more substantial device such as a laptop computer is not available. It is better to have a cell phone, than no computing device at all. As the cell phones become more powerful, they continue to erode the appeal of carrying a larger, institutionally controlled laptop computer. In their discussion on the implications of disruption in education, Norris and Soloway (2009) make a point significant to this review. They refer to failure, which is an effect of disruption. They state that “companies tend not to survive disruptive technological changes. That is, a company that is successful in one technological epoch doesn’t tend to survive into the next epoch” (Norris & Soloway, 2009, para. 1). The authors also quickly concede that USA public schools are unlikely to fail in the same way that a corporation may fail. That is, a public school is unlikely to close or become insolvent. However, the implication is that schools will continue to face significant pressure from disruption as technologies (in this case, cell phones) become more pervasive. Students turn up to school and make deliberate decisions that go against the mainstream (in this case, institutionally provided technology devices). The parallel in this research study is that despite lower participation rates in technology and languages, students continue to elect these fringe subjects. Students make choices based on their perception of value which appears to be different from the mainstream, and this creates continued pressure on administrators with respect to resources and staffing. ‘Failure’ in this context is considered as the persistent strain on administration, and the potentially unrealised value of technologies and languages subjects. It is suggested that using a disruptive frame to investigate these value perceptions held by students can shed light on what motivates them to make these choices.

Proceeding from the perspectives of disruption stated above, Nowell (2014) investigated “how secondary teachers utilise disruptive technologies and for what purpose” (p. 110). The study contributes to this review as it involves the key element of ‘choice’, i.e., “why teachers and students chose certain new media technologies and what they gained from its use as an educational tool” (Nowell, 2014, p. 112). As a qualitative study, narrative enquiry was used to “interpret multiple meanings and understandings” (Nowell, 2014, p. 113) of “teachers’ and students’ concerns over media and digital literacies, the digital divide, and digital teacher-student relationships” (p. 112). Findings revealed some elements of ‘disruption’; however, they were not labelled as such. Teachers’ and students’ desire for increased use of technology was mutual, yet the motivation was different. The study revealed that as teachers experimented with technology platforms that suited their work methods, “students engaged with social media for personal, not educational use” (Nowell, 2014, p. 119). Tension also arose in teachers as they collided with school restrictions on technology use in the classroom, resulting in some teachers deliberately circumventing institutional controls. Asymmetry of motivation, and the deliberate choice to side-step restrictions in favour of a faster more personalised solution are typical of ‘disruptive’ behaviour (Christensen et al., 2004). It is unclear from the study as to whether participants were aware of their actions as being considered disruptive. The ‘disruptive’ label

was reserved for the devices being used; hardware and software such as mobile phones, computers, and social media platforms.

Another factor typical of disruption emerging from the study is the creation of new value (Christensen, 2013). Whilst the students and teachers made some improvement in their communication and interaction in the digital space, the process encountered resistance and the outcomes were not ideal. However as teachers in the study navigated these obstacles, they "cited the teacher-student relationship – the social-emotional bond that connected the groups – as the driving force for their endeavours to connect with students through technology" (Nowell, 2014, p. 119). In simple terms, merely opening the teaching and learning process through digital devices did not lead to clearly measurable improvements in outcomes. However, the experience led teachers to strongly value the student-teacher relationships when engaging online, and this was considered an unexpected find by the researchers; moreover, that this could inform future practice (Nowell, 2014). It could be argued that to find this new value, teachers and students had to engage in an environment which was considered 'not as good' as trying to work within the constraints of the school. Before improvement could be made, a potentially lower value proposition was accepted and experimented with.

Therefore, there is evidence of disruptive forces at work in the Nowell (2014) study. However, the disruptive label is not discussed in terms of participants behaviours, choices, or perceptions of value. Rather, it is the devices that are labelled as disruptive, which is consistent with the initial research question of how students utilise the devices. The study by Nowell (2014) is relevant to this review in that it highlights an opportunity to further explore the frame of disruption in student decision making. In the case of the Nowell (2014) study, the disruption is not experienced through the interaction with a device or technology platform, but with an endeavour (i.e., subject choice). Moreover, that the endeavour was not something introduced as part of a research project, but that students were already participating in it, and experiencing the value they had ascribed to their subject choice.

In contrast to the work by Nowell (2014), the investigation presented by Powell et al. (2015) provides an example of two higher education case studies in the United Kingdom, which are explicitly analysed through the lens of disruptive innovation. The researchers base their study on the theoretical frame of disruptive innovation as documented by Bower and Christensen (1995). As part of their analysis Powell et al. (2015) also raise the significant disruptive issue of failure, which is also raised in the study by Norris and Soloway (2009). The analysis centres around a tertiary curriculum model labelled as 'work-focussed learning' which offers full time workers the opportunity to complete an undergraduate degree as part of their paid (or voluntary) full time work. Powell et al. (2015) note that "from an institutional perspective this is a new pedagogical model that allows an HEI (Higher Education Institution) to address an unserved market segment" (p. 3). That is, students who would not otherwise be able to, or afford to

pursue tertiary study, now have an opportunity to do so without interrupting their work. For both the HEI and the student, there is an opportunity for 'new value' based on a product that might be considered inferior to the incumbent full-service offering.

Two HEIs offered degree programs based on the 'work-focussed' learning model, but with significantly different methods of implementation. The difference is important to this review as it highlights a critical factor contributing disruptive innovation failure. For brevity, the two methods are summarised below.

> **The Ultraversity project** – set up as a semi-autonomous unit that developed an undergraduate degree programme with its own marketing, recruitment and enrolment processes, significantly reduced fee structure, and a dedicated staff wholly focussed on supporting the students online.
>
> **The IDIBL (Interdisciplinary Inquiry Based Learning) project** – an institution-wide change initiative with the aim of taking the successful work-focussed learning approach and creating courses based on it, to be delivered by the various faculties on of the institution.
> (Powell et al., 2015, p. 4)

At high level, the different approaches to implementation summarised above are very similar to the examples of Western Governors University (WGU) and the University of Southern California (USC) described earlier (Liu, 2013). One approach is to form a separate business unit or unique enterprise that offers a different product to underserved customers (WGU and Ultraversity). Whereas the alternate approach is to reach underserved customers by adding a disruptive product onto the incumbent high-value product offering (USC and IDBL). The IDBL project was also similar to the USC project in that it did not compete on price by offering substantially lower fee structures. An in-depth review of the structure of these offerings is beyond the scope of this review. However, the future path of each program is noteworthy. In each case, the courses experienced pressure and ultimate decline, but for different reasons. Initially, the Ultraversity project recorded healthy enrolments, and then numbers steadily declined after the first three years of the program running. Whilst initially set up as a semi-autonomous unit within the university, an "institutional reorganisation" saw Ultraversity "drawn into the main body of the HEI where it has had to move towards the norm in terms of fees, rules and regulations, and the organisation of the teaching team" (Powell et al., 2015, p. 8). Moreover, Powell et al. (2015) note that the marketing function no longer targeted the underserved customers, further draining potential recruitment into the course. Powell et al. (2015) attribute this shift in governance as a major contributing factor of failure. This is consistent with Christensen (2013) who notes that without autonomy, innovative initiatives such as Ultraversity are unlikely to survive as the performance metrics of the disruptive offering are then measured against those of the current

high-margin offerings. Ideas which threaten to take market share from existing products are quickly rejected. The IDBL model also faced significant pressure internally. Given that the new courses were “to be delivered by the various faculties of the institution” (Powell et al., 2015, p. 4), the initiative never benefited from the autonomy that Christensen (2013) states is so important for success. Powell et al. (2015) report that “the framework was never embraced by the majority of staff as an internal model, the reaction ranging from interest but uncertainty as to how to engage through to outright hostility” (p. 9). Given the lack of autonomy at the outset, it is arguable that the failure of the IDBL project was highly probable.

In the context of this review, the Ultraversity and IDBL projects illustrate that successfully implementing educational innovation is complex and can fail on a large scale. Powell et al. (2015) analyse the two case studies through the disruptive lens, although there is no indication in their analysis that the projects were implemented with ‘disruptive’ intent. That is, the HEIs had intent to implement innovative pedagogy but were unaware of the potential failure factors that accompany disruptive innovations. There is little doubt as to the recognised need for innovation in education. This is highlighted by initiatives such as the previously stated innovation types by OECD Centre for Educational Research and Innovation (CERI) (2008) of ‘product’, ‘process’, ‘marketing’ and ‘organisational’, and that innovation in education should be research backed (We et al., 2017). However, the Powell et al. (2015) analysis highlights that stakeholders in complex structures such as HEIs may be approaching the innovation from multiple perspectives. This has the potential to generate wide-ranging reactions, which in the case of a disruptive innovation can substantially weaken the chances for success. Whether the stakeholders in the Ultraversity and IDBL projects knew that disruptive forces were at play is not stated by Powell et al. (2015), and whether this could have made a longer-term difference to the success of the projects is unknown. This indicates that assumptions made about implementing innovations can yield mixed results due to lack of understanding or awareness about what kind of innovation is being implemented. An example of this kind of assumption is present in a study on flipped learning by Wilson (2020).

The inclusion of the Wilson (2020) study in this review provides insight into the way in which ‘disruption’ is referred to in the context of an implementation of flipped learning. The study investigated the “effectiveness of using Flipped Learning pedagogy in a final year teacher education course” and sought “to understand if the Instructor’s modelling of Flipped Learning pedagogies would influence the pre-service teachers’ use of the pedagogy” (Wilson, 2020, p. 5). An important point to note, is that in this case, the instructor is also the researcher. Wilson (2020) cites work by Bergmann and Sams (2012) stating that flipped learning is “widely understood as an approach where discipline content is delivered outside of the classroom thus freeing up time during lessons for student discussion and application of concepts” (p. 1). The study focuses primarily on using the freed up time in classes to focus on “face-to-face scaffolded learning activities”, with the impact to “affect increases (indicated by higher grade

scores) in the more challenging application of critical course content and skills" (Wilson, 2020, p. 2). The study makes no reference to 'disruption' as part of the underlying framework for investigating the impacts of flipped learning. Although, flipped learning has been associated with disruptive innovation in education in that it can offer a solution to learners who are underserviced by their current school environments (either secondary or tertiary). In the adaptation of disruptive innovation to education, Christensen et al. (2010, p. 38) contend that "computer-based learning is emerging as a disruptive force and a promising opportunity" for student-centred learning. This effectively reduces the focus of the teacher as the source of learning content and knowledge. Christensen et al. (2010, p. 38) explain that properly implemented technology platforms can have the effect of shifting the role of the teacher to a "guide on the side, not a sage on the stage". A decade later, Wilson (2020) echoes this language and investigates the flipped learning concept with a search for creating new value in improved student results. In doing so, Wilson (2020, p. 2) also concedes that "students' access to the sage on the stage" had been denied; replaced by asynchronous learning activities.

The Christensen et al. (2010) text does not label the disruptive use of computer-based teaching methods as flipped learning, and the study by Wilson (2020) does not use disruptive innovation as a frame for investigation. Although Wilson (2020) does make a minor reference to disruption in the concluding statements. Whilst an in-depth analysis of the Wilson (2020) study is beyond the scope of this review, the overarching findings of the study are pertinent. Overwhelmingly, the feedback from pre-service teacher participants was negative. As the researcher sought new value using innovative pedagogy, the students experienced reduced value. Of note, is that the study does not indicate that students experienced any less face-to-face time with their instructor. Rather, that previously conducted face-to-face learning tasks had become asynchronous to make room for "the application of newly acquired subject and curriculum knowledge" (Wilson, 2020, p. 5). This is an important aspect of the research context. Students indicated through prior feedback that there was not enough time to apply new knowledge, and then through the innovation found that there was even less time. Also significant is that there was no indication that students were given any kind of induction or onboarding to the new flipped learning model. This is a likely contributor to feedback received which referred to increased discomfort with using flipped learning resources and the perception of lost time with the instructor, and therefore the potential to miss out on important details in the coursework (Wilson, 2020).

In the final statements of the study, Wilson (2020) remarks that "it is exceedingly difficult for an individual instructor to enact a disruptive pedagogy when there is a broader, long standing and accepted view of what successful teaching looks like" (Wilson, 2020, p. 12). At this point, it is important to reiterate that it is not the intent to critique the nature or findings of the Wilson (2020) study. However, it does illustrate an example of the mixed perceptions of education innovation, and what might be considered disruptive, which is a focus of this review. The

researcher conceded that it was difficult to implement a disruptive pedagogy, however the method of implementation suggests that flipped learning in this context served more as a sustaining innovation. That is, what was perceived as disruptive, in hindsight was in fact implemented to augment, and improve upon an existing course, rather than to provide an alternative to ‘no course’. The instructor’s desire to respond to feedback and provide new value, resulted in a perception of less value by the students (aka customers). The resistance (or failure) experienced in the study is therefore consistent with failure as described by Christensen (2013).

The preceding discussion highlights the complex landscape for interpreting innovation in education contexts. There is broad agreement on the need for innovation, and the examples discussed illustrate myriad attempts from a policy and practice perspective for implementing innovative approaches in education. Examples of ‘disruptive’ innovation range from general, or even cursory labels, to instances where disruptive innovation is labelled and explored in a manner that closely aligns with the theory as described by (Christensen, 2013). When considered in the context of student conceptualisation of technology and languages subjects and the value propositions identified by students within those subjects, the theory of ‘disruption’ offers a unique opportunity. The examination of value held by students operating outside of the mainstream requires a reframing of conventional approaches to innovation to address the research questions. To provide a basis for discussion of findings in this thesis, the following conceptual frame is developed.

2.11 Conceptual Frame

This thesis addresses the relationship between conceptualisation, motivation, and value proposition as expressed by secondary technology and languages students. The research questions (Chapter 1.5) examine student conceptualisation, value proposition and motivation, and complementary value between technology and languages subjects.

Conceptualisation is examined using concept map analysis (Novak, 1995), which also has the effect of identifying propositions proceeding from student conceptualisation. Perceptions of value identified in concept maps, and the implications found within, are discussed through the lens of disruptive innovation (Christensen, 2013) as paralleled to the research context (Chapter 2.9). The conceptual frame can be represented diagrammatically as in Figure 1 below.

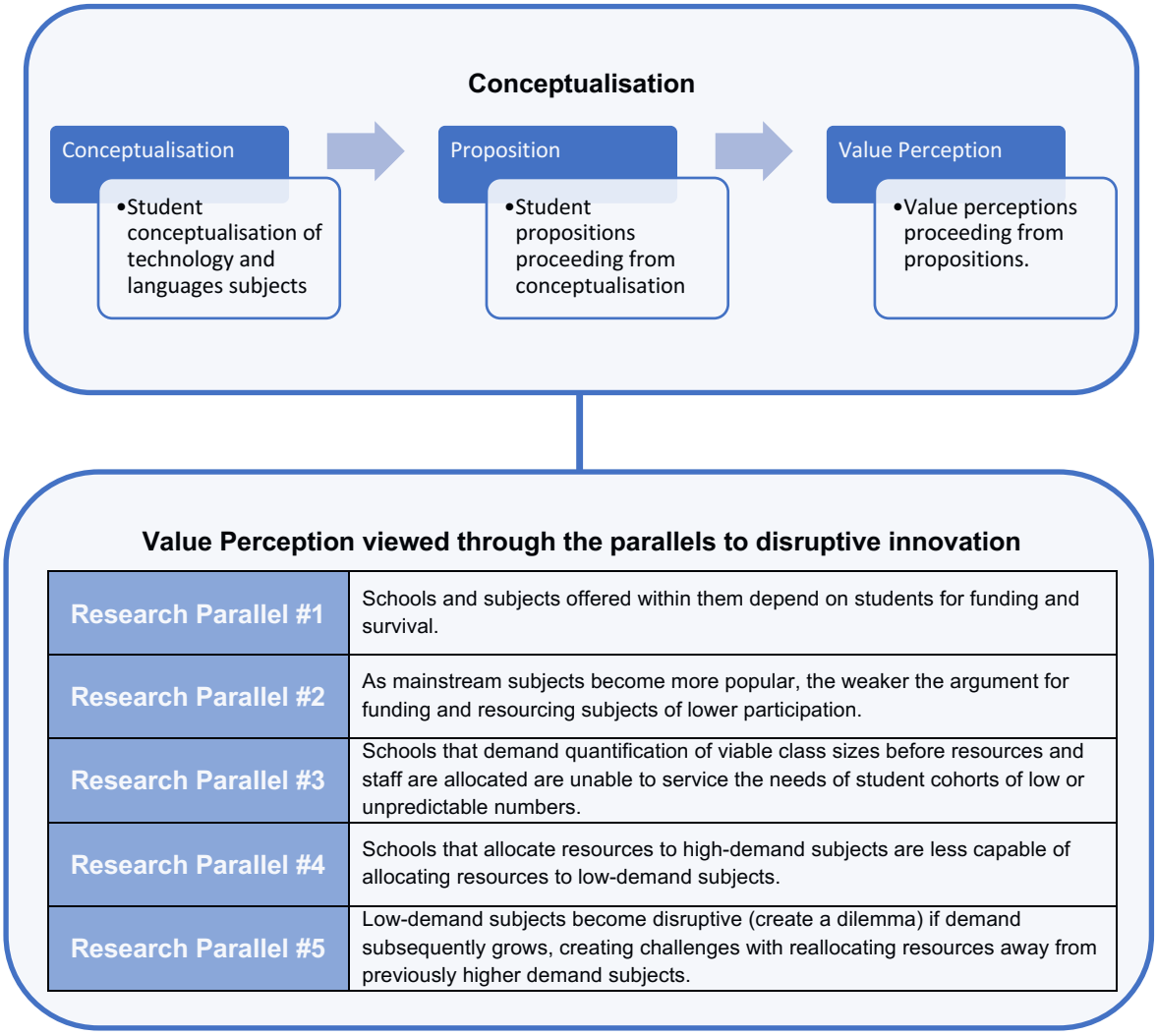


Figure 1 Conceptual Frame

Chapter 3: Methodology

3.1 Overview of the Study

This study has examined student conceptualisations of technology and languages subjects in 3 coeducational independent K-12 schools. The student conceptualisations are underpinned by the research questions stated in Chapter 1.5. The schools are regionally diverse and were selected for the following reasons.

- Access – the researcher has taught on a casual basis periodically at School A. The researcher has conducted a professional development seminar for teachers and a student workshop at School B. The researcher has previous contact with staff at School C. This familiarity proved invaluable in contacting schools given the COVID-19 pandemic.
- Key similarities and differences in school type, location, and context are outlined below.

School A – an independent coeducational, K-12 Christian school, located in the Hunter region 150km north of Sydney.
School B – an independent coeducational, K-12 Anglican school, located in the Australian Capital Territory.
School C – an independent coeducational, K-12 Anglican school, located in Western Sydney.

School C was included in the study after initial analysis from Schools A and B revealed that further data may emerge with a larger data set.

The three schools are similar in size, socio-economic demographics, and are all coeducational. At the time of data collection, a range of elective technology and languages subjects was offered at the schools. A notable difference at School A is that it offers a dedicated iSTEM course in addition to the broader technology courses offered at Schools B and C. School A also offers only one elective languages course (French) which operates when demand exists. Demand for languages electives at School A is generally low. Schools B and C offer a wider range of languages courses (including distance language courses) due to generally higher demand for languages.

3.2 Research Design

The wide range of technology courses and conceptualisations for STEM suggests an ontology of multiple realities for the realisation and implementation of technology education. This leads to the assumption that conceptualisations for STEM/technology will vary between research sites

and that these will need to be uncovered. The methodology for this study collects visual and verbal data to identify how knowledge has been constructed about the subjects. Individually, the research sites may be considered as complex societies. Specifically, the students and teachers within STEM programs are also engaged in navigating the complexities of STEM, and as Berger and Luckmann (1966) suggest, this does not mean that they are actively engaged in the theoretical interpretation of STEM. That is, they participate in it, yet may not theorise about it. Similarly, students and teachers in technology courses may consider themselves engaged in STEM like activities, yet not theorise about the notion of STEM. The interpretivist perspective taken in this study will offer the opportunity for participants to engage on the theoretical level, providing opportunity for depth in responses.

The interpretivist approach used in the three research sites enabled analysis that could deeply compare and contrast responses. Data were collected in the following forms.

- Primary data source - students' conceptualisations recorded in hand-drawn concept maps.
- Supporting data source - semi-structured interview

In the context of this study, the above two forms are both considered as 'texts'. This study is not a mixed methods study. Rather, the use of primary and supporting data sources enabled participants to express their responses more fully if they felt limited or hindered by their drawing capabilities. The primary data source is supported by the additional strategy of semi-structured interviews. How these data sources are analysed under the over-arching method for analysing concept maps is discussed further in Chapters 3.4 and 3.5.

3.3 Sampling and Ethics

Ethics approval was granted by the University Human Research Ethics Committee on 1 May 2020 to conduct data collection in accordance with the research design (Appendix A). As a part of the approval process, the ethics committee required that an alternative method for data collection be provided if schools were impacted by the emerging COVID-19 pandemic. A second approval was sought to include a third school in the study, Schools C, and was approved on 14 October 2020 (Appendix B).

Shortly after ethics approval was granted in May 2020, the COVID-19 pandemic put many schools into lockdown. This made communication with schools very difficult, as schools placed restrictions on visitors to their campuses. Pandemic related pressures notwithstanding, data collection successfully commenced in September 2020.

The participants targeted for the study include year 9 and 10 students in technology and languages courses. This enabled data to be collected from students who were at the beginning or nearing completion of their 2-year course. Teachers were also invited and one teacher from School A participated. The spread of progression within each subject presented an opportunity to draw conclusions about perceptions both early and late in the courses and how and whether perceptions change.

Participants were recruited via an opt-in selection process. The selection criteria were,

- students must be in year 9 or 10, as the study investigates elective subjects
- students may be studying a STEM or 'technology' subject, or both.
- students may be studying any language other than English, on campus or via distance.
- students may be studying a language other than English, and a technology subject.

Sample numbers were targeted as shown in Table 1 below.

Table 1 Target Participant Numbers

School	Stage	Participant Numbers
School A	Year 9	5 students, one teacher
	Year 10	5 students, one teacher
School B	Year 9	5 students, one teacher
	Year 10	5 students, one teacher
School C	Year 9	5 students, one teacher
	Year 10	5 students, one teacher
Total		Up to 30 students Up to 6 teachers

The target numbers were considered sufficient for the following reasons,

- to maintain an appropriate sample size for an interpretivist, qualitative study
- time for data collection in schools is limited, particularly considering COVID-19
- the intended grounded analysis approach for further students to opt-in should it be considered that data saturation has not been reached with only 2 schools.

Actual participant numbers varied from the target sought (see Table 2, below). Documentation relating to participant information and consent, and the right to decline to participate and withdraw at any time without negative consequences is provided in information provided to participants in Appendices C and D.

Table 2 Participant Numbers

Student Participants																															
	iSTEM				Design and Technology				Information & Software Technology				Engineering Studies				French				Indonesian				Tamil				Russian				
Gender	M		F		M		F		M		F		M		F		M		F		M		F		M		F		M		F		
Year	9	10	9	10	9	10	9	10	9	10	9	10	9	10	9	10	9	10	9	10	9	10	9	10	9	10	9	10	9	10	9	10	
School A	1	4																															5
School B					4	3	2	1									1	1	5	1			1	2				1				1	23
School C										1						1	2	2	4	2													12
Totals	1	4			4	3	2	1		1						1	3	3	9	3			1	2				1				1	40
Teacher Participants																																	
School A	nil																																
School B	1 Design and Technology, male																																1
School C	nil																																

Onsite vs. remote data collection

Data were collected onsite in each school. Whilst an alternate data collection method via remote means was approved, all three schools preferred an onsite approach.

Participants were arranged into groups at each school in a way that produced the least disruption to school routine. Generally, the groups were separated between languages and technology for reasons of scheduling.

School A – all iSTEM, year 9 and 10 together.
School B – languages and technology separated, but with both year 9 and 10 together in the session.
School C – languages and technology combined, with both year 9 and 10 together in the session.

At School B, the Design and Technology teacher participated with the technology students.

3.4 Methods and Techniques

The aforementioned methods of concept maps and semi-structured interviews are similar to, and build upon methods used in the study by Holmlund et al. (2018). Given that results in the study provided useful findings, it is anticipated that similar methods will yield useful findings in this context also. The unit of analysis in this study is the ‘individual’, either student or teacher.

In recognition that students may feel compelled to provide the 'right or wrong' answer, instructions for concept maps and interview questions were written in such a way as to

- Minimise the potential for participant responses to satisfy a hidden agenda. For example, participants may suspect the study aims to assess their knowledge and performance in the subject.
- Prevent the researcher from asking 'leading' questions to create a perception of a problem where one potentially does not exist. For example, students may feel coerced into artificially expressing negative sentiment towards their subjects or expressing deficiencies about their subjects.

Concept map samples and instructions are provided in Appendix E.

Figure 2 below illustrates the sequence of concept map and interview data collection.

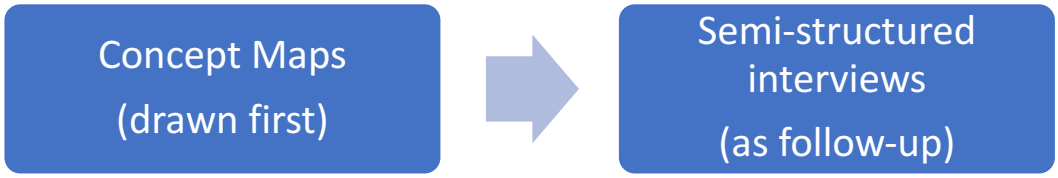


Figure 2 Concept Map - Follow-up Interview Sequence

3.4.1 Concept maps

With brief stimulus material and instructions (Appendix E), participants produced concept maps comprising words, sketches, diagrams, or a combination of those elements. Each participant produced one concept map contained within one A3 page. This is considered appropriate for illustrating how a participant structures knowledge and makes ideas explicit in a specific domain Novak (1995). In effect, concept maps can draw out a key component of sensemaking in that participants' thoughts become visible, providing a physical artefact upon which to reflect and provide further insight. As Weick (1995) suggests, participants may not know what they think until they engage with the data collection instrument or express themselves in follow-up interviews. Similarly, in the Holmlund et al. (2018) study, participants were given the opportunity to discuss their drawn responses, in recorded interviews, to further clarify detail.

Concept maps were created in the space of approximately one lesson, ranging from 50 – 100 minutes.

3.4.2 Follow-up interviews

Participant interviews were conducted after the creation of concept maps, allowing participants to further reflect upon, and clarify their concept maps. The study recognises that unstructured interviews are more typical for a grounded theory approach (Denscombe, 2007). Yet for this study, the interviews took a semi-structured format, given that students may require some guidance to maintain focus on the task.

Despite each school preferring onsite data collection approach, each data collection session was guided by scheduling and time efficiencies, as visitor permissions in each school were heavily restricted due to COVID-19 protocols. Interviews were therefore held immediately after each drawing session to minimise the time for each session. The recording equipment comprised a secure, password-protected iPhone (and iPad for backup). For audio quality, the researcher used the iPhone as a roaming microphone in a dynamic interview style. Interviews were transcribed for analysis by a professional, secure transcription service.

To assist with reliability in conducting semi-structured interviews (Flick, 2023), a run sheet was used to guide the interview questions. They are outlined below. Note that the opening points allowed for the discussion to take two potential paths. It was also anticipated that participants may respond between these two points.

Opening points included,

- Thinking back, can you describe your concept maps with keywords?
- How do you think your original motivation to do/teach the subject is reflected by your keywords?
- What were the kinds of concepts you found difficult to draw? Why?
- How would you describe those now in conversation?
- Where do you think the primary areas of focus in the subject are?
- What areas have arisen that you weren't expecting?

Following these points, it was anticipated that the discussion could proceed down two paths based on how culture, intercultural, and global elements surfaced (shown in Table 3 below).

Table 3 Follow-up Interview Paths

YES Culture, intercultural, global elements surfaced	**NO** Culture, intercultural, global elements did not surface
• Interesting you mention culture. Why does this arise for you? • To what extent do you think your endeavours in STEM should impact other cultures or nations? • At what point would it perhaps prompt you to learn about the other culture more deeply, or perhaps even to learn its language? • When you think of the reasons for doing iSTEM, or its rationale, where do you see potential overlap with other subjects? • Do you think languages might fit alongside STEM? Why, why not, what reasons?	• Describe what you think the rationale for iSTEM might be. In other words, why do it? • How do you think culture, and a 'global' awareness might play a role? • If you were to think about iSTEM fitting alongside other subjects, which ones might they be? Why? • Imagine yourself in the future as a STEM worker. What accompanying skills do you think would be valuable? Why? • Where do you think this subject is deficient? • What would you like to see more of?

3.4.3 Phase 1 and Phase 2 data collection sessions

Data were collected in two Phases as indicated below.

Table 4 Data collection dates

	Phase 1	Phase 2
School A	09/09/20	27/11/20
School B	22/09/2020 – 23/09/2020	01/12/2020 – 02/12/2020
School C	04/05/2021	28/05/2021

In Phase 1 participants produced their initial conceptualisations via concept map creation and follow-up interview. These data were then analysed. Conceptualisations created by technology students were then used to create revised focus questions for languages students, and vice versa.

In Phase 2, the process of concept map creation and interview was repeated. This time, revised focus questions developed from Phase 1 analysis were provided to technology and languages students as stimulus.

The purpose of the Phase 1 / Phase 2 approach was to ascertain whether the conceptualisations of each group of participants would influence the other. The sequence of data collection is outlined in the table below.

Table 5 Data collection sequence

Date	School	Description
09/09/2020	A	• Phase 1 data collected with version 1 focus questions
22/09/2020 – 23/09/2020	B	• Phase 1 data collection with version 1 focus questions
		• Analysis of Phase 1 data from Schools A and B • Creation of 'version 2 focus questions' for Phase 2 data collection
27/11/2020	A	• Phase 2 data collection with 'version 2 focus questions' based on Phase 1 analysis of Schools A and B
01/12/2020 – 02/12/2020	B	• Phase 2 data collection with 'version 2 focus questions' based on Phase 1 analysis of Schools A and B
04/05/2021	C	• Phase 1 data collected with version 1 focus questions
		• Analysis of Phase 1 data from School C. • Phase 1 analysis from School C to create 'version 3 focus questions'. • 'Version 3 focus questions' created based on analysis of Phase 1 data of Schools A, B and C.
28/05/2020	C	• Phase 2 data collection with 'version 3 focus questions'

3.5 Data Analysis

3.5.1 Previous studies: visual analysis

Studies employing visual methods are increasingly being adopted by education researchers. The following examples provide context for the use of concept maps as a method for visual data collection and analysis.

In a study investigating students' literacy knowledge Kendrick and McKay (2002, p. 47) cite Prosser (1998) in claiming that "only within the last three decades have qualitative researchers given serious consideration to the use of images to enhance understanding of the human condition". They note that Prosser

> argued that image-based research is differently situated from other forms of research because visual images are different in nature from words in their allusion to reality and in the ways in which participants see themselves and can be seen by others. (Kendrick & McKay, 2002, p. 47)

Kendrick and McKay (2002, p.48) describe the use of drawings in their study as an "innovative way to understand the literacy narratives that children construct across the broad contexts of their lives". They also refer to Vygotsky's (1978) socio-cultural theory where Vygotsky views "drawing as a way of knowing" and "as a particular kind of speech" (Kendrick & McKay, 2002, p. 46).

Acar et al. (2012) conducted a qualitative study amongst 1st and 5th grade mathematics students to gain their perceptions of their teachers. The instruction was simple; "Draw the math teacher of their mind, or dreams" (Acar et al., 2012, p. 4329). 36 drawings were collected. One week later students wrote about their drawings. A content analysis was conducted with drawings and writings analysed separately. There was no statistical analysis. The study was concerned with how the perceptions of maths teachers would change between the 1st and 5th grade. The researchers cite scholars supporting the use of drawings in this method; that drawings can be "a means of revealing mental images", and be "markers and mirrors of personal identity" (Acar et al., 2012, p. 4328). In addition, Chula (1998) claims that drawings can be "used as tools for "projection" to discover children's visions of their ideal worlds" in Acar et al. (2012, p. 4329).

Other contexts include the curriculum area of science, as documented in two studies by Bowker (2007) and Desjean-Perrotta (2013). Bowker (2007) conducted a quantitative analysis of primary school students' knowledge of a tropical rainforest where students produced drawings prior to and after visiting the Eden Project biome in Cornwall, United Kingdom. The researchers claimed that their method was constructivist "in the sense that it does not assume that learners enter with comparable experience and knowledge" (Bowker, 2007, p. 82). A quantitative scoring method was developed based on Personal Meaning Mapping methodology (Falk & Dierking, 1992, 2000) which "took into account the breadth, extent, depth and mastery of themes in each drawing" (Bowker, 2007, p. 82). Participants were also interviewed about their drawings to verify features. Findings from the study indicated that 'post' drawings illustrated a significant increase in rainforest plants and environments. Noteworthy is the suggestion by the researchers that this knowledge was made visible because students were "given the opportunity" to "reveal what they know and understand through drawings" (Bowker, 2007, p. 94).

Referring again to the study by Kendrick and McKay (2002, p. 47), the researchers note how Prosser (1998) “asserted that images provide researchers with a different order of data and an alternative to the ways in which researchers have perceived data in the past”. In this context it is important to note that Prosser recognised language as a “dominant form of data and method of communicating findings in social research” (Prosser, 1996, p. 25) and that a clear methodology was required to “enhance the status and acceptability of image-based research” and how “image-based research can make positive and substantial contributions to qualitative research” (Prosser, 1996, p. 25). Whilst not all studies discussed reference this issue explicitly, it is implied by the wide use of interviews and written text required of participants as a support, further verification, or triangulation of the ‘content’ of their drawings. Additional discussion of how verbal ‘support’ was collected and reduced is provided in Chapter 3.7.2.

It must also be noted that Prosser did not limit the moniker of ‘image-based’ to images but included a “wide range of visuals” including “film, video, photographs and cartoons, within a qualitative research context” (Prosser, 1996, p. 25). This study assumes the position that the participant-produced drawings of concepts maps collected fall into this ‘wide range’.

The consideration of participant-drawn images (drawings) as a visual research method places this study in the context of images that are created and then subsequently analysed, as opposed to the analysis of pre-existing images. This is a method commonly employed in social research including educational studies (Banks, 2007). In the aforementioned studies, a commonly cited approach to analysing the drawings is ‘content analysis’. Bell (2001, p. 15) states that the ‘content’ of a content analysis may be “visual, verbal, graphic, oral – indeed, any kind of meaningful visual/verbal information”. For brevity of description, these are broken down into “visual/verbal units of meaning” which are “isolable, self-contained or separate, like paragraphs, framed images, pages or news photographs”, all of which are generically labelled as ‘texts’ (Bell, 2004, p. 15) (Also noted in Section 3.2 Research Design). This description discusses content analysis in the context of media research. However, the definition includes “any kind of meaningful verbal/visual information” (Bell, 2004, p. 15) and the studies previously cited widely adopt ‘content analysis’ in their methodologies. The notion of visual/verbal units of meaning also resonates with traditional approaches to analysing concept maps as described by Novak (1995). This study therefore also considers content analysis as a viable data analysis method. The type of content analysis then needs further definition.

Drisko and Maschi (2015) and Schreier (2014) offer a method that resonates with the research objectives: qualitative content analysis. Qualitative content analysis is described “as a set of techniques for the systematic analysis of text of many kinds, addressing not only manifest content but also the themes and core ideas found in texts as primary content” (Mayring, 2010) in Drisko and Maschi (2015, p. 82). Moreover, “qualitative content analysis does not employ

statistical analytic methods", is not generally used for "broad critical analyses" and "usually maintain[s] a more descriptive focus" (Drisko & Maschi, 2015, p. 82). Themes, core ideas or the meaning of qualitative data are assigned to categories of a coding frame in a systematic, yet in a flexible way (Schreier, 2014). The flexibility allows the "researcher to focus on selected aspects of meaning, namely those aspects that relate to the overall research question" which also has the effect of reducing the data (Schreier, 2014, para. 2).

Both Drisko and Maschi (2015) and Schreier (2014) also acknowledge criticisms of quantitative approaches raised by Kracauer (1952), who argued that

> (1) meaning is not always manifest; (2) that meaning is often complex, contextual and best determined holistically; and (3) that some meaningful content may appear only once in a text, which does not necessarily mean it is not important or meaningful. (Drisko & Maschi, 2015, p. 83)

Drisko and Maschi (2015, p. 84) offer two further limitations identified by Ritsert (1972) who claims that,

> (1) the distinctive nature of individual cases may be lost in manifest content analysis and that communications that do not appear overtly in the text may be overlooked; (2) Omissions of expected content, or the removal of content, require contextualised analyses.

When considering the research question and instructions to participants in this study, the above definitions and criticisms begin to provide a clearer case for using a qualitative content analysis approach.

3.5.2 Concept map analysis

As Novak (1995, p. 82) states, concept maps are a tool for representing knowledge in a highly condensed, hierarchical structure and can "serve as a template for students' understanding". Yet in a paper by Srivastava and Hopwood (2009, p. 81), Hopwood notes the importance of "balance" in data of this nature, and whether the data can be taken at face value. As such, an iterative and reflexive process is proposed. This resonates with the persistent process of comparison as new data are collected (Denscombe, 2007). Combining concept maps with follow-up interviews also contributes to data validation between visual and spoken data.

Concept maps were used with participants as a specific starting point, as distinct from other forms of 'mapping' that students may have encountered such as 'mind mapping' or

‘brainstorming’. This is because the research questions have a clear objective to not only identify the structure of knowledge displayed by concept maps Novak (1995), but also to uncover ‘value’ through the factors that influenced their choice to study the subject. The notion of ‘proposition’ in the concept map analysis framework enables this link (described below).

Novak and Cañas (2008, p. 1) define a concept “as a perceived regularity in events or objects, or records of events or objects, designated by a label. Usually a label is a word, but it may also be a symbol”. The variation in geographical location of the selected schools also plays a role. Novak (1995) states that “since concept meanings derive from the context in whey there were learned, culture and experience have an impact, so no two individuals conceive precisely the same meaning for any concept label”. This means that the variation in geographic location may become evident in the analysis.

In the typical use of concept maps as described by Novak (1995), concept labels are ranked in order; most general and most inclusive, to the most specific and least inclusive. The ranking is represented in a hierarchical structure with “the more general concepts at the top of the map and the most specific concepts at lower levels” (Novak, 1995, p. 81). Whilst the participants were presented with this structure (including a printed typical example) they were not limited to it. This reflects the use of concept maps in the study by Holmlund et al. (2018) where students were not limited to the typical concept map structure. The purpose of removing the limitation of typical concept map structure reflected an objective of the study to not only represent knowledge of the subjects studied, but to identify student conceptualisations. Participants were reminded that the exercise was not an assessment of knowledge as prescribed by the curriculum, rather an expression of their conceptualisation of what they were studying.

Once the major concepts are established, relationships and statements (or propositions) that convey specific meaning are identified (Novak, 1995). Typically, when concept maps are used to represent knowledge such as curriculum content, “lines are drawn between pairs of concepts, and labels are selected to indicate the relationship between these concepts” (Novak, 1995, p. 81). In contexts where concept maps are used for assessment of knowledge, the correctness of the relationships is significant. In this study, participants were reminded that their conceptualisations were not being assessed for correctness and that this allowed them freedom to depart from the sample concept map structure provided if that better suited the expression of their conceptualisation. The lines drawn between concepts were still considered as relationships. In accordance with concept map analysis, statements observed as groups of words, short phrases or images/sketches that could convey ‘specific meaning’ were labelled as ‘propositions’.

The procedure for analysing the concept maps therefore followed the steps of identifying,

- Concepts

- Relationships
- Propositions

At high level, the concept maps produced across the three sites were broadly similar in appearance and structure. Closer inspection revealed varying levels of detail, from very simple to highly complex. As such, the procedure for analysis was not strictly sequential and required an element of iteration to ensure that links were correctly interpreted. This is consistent with the typical approach proposed by Novak (1995, p. 82) where interrelationships between concepts via “cross-links” may be evident. Notably, Novak (1995) states that “it is possible to link every concept with every other concept in some way, but only the most salient cross-links should be recorded on the map” (p. 82). Since participants were not limited to drawing what they considered to be only the most salient links, the process of data reduction recorded only what appeared to be the most dominant or salient links drawn by participants.

3.5.3 Qualitative content analysis of concept maps

Novak (1995, p. 84) states that “there is no one scoring formula that is most appropriate for concept maps, since concept maps may be used for a wide variety of purposes”. As stated, these purposes include representation and assessment of knowledge, yet the purpose in this study is to identify student conceptualisations. In the use case of assessment of knowledge, correctness or relevance of concepts in a given domain of knowledge are scored (Novak, 1995). Further, the relationships (including cross-links or interrelationships) are also “checked for accuracy and one or more points assigned for each” (Novak, 1995, p. 84). Yet this study is not assessing participants’ knowledge, and a scoring system becomes less useful. Therefore, the previous discussion on visual analysis methods becomes helpful. The connection between the content of a concept map, and the definition of content as offered by Bell (2001), opens the opportunity to develop a procedure for analysis based on qualitative content analysis (Drisko & Maschi, 2015; Schreier, 2014) . This procedure involved the process of reducing the data and arranging concepts, relationships, and propositions into themes for analysis.

3.5.4 Previous studies: semi-structured interviews

The purpose of conducting follow-up interviews was to allow participants to further reflect upon and clarify the concept maps they had just produced. Whilst the concept maps formed the primary data source, the interviews enabled students to communicate their responses in a way that their ability to draw, or graphically represent might have hindered or restricted them. It is important to note that interviews were not conducted to open a new line of enquiry. Nor to introduce a new method as in a mixed methods study. Rather, semi- structured follow-up

interviews further supported visual data collected through concept maps. This section outlines how semi-structured interviews have been used in a range of contexts in education research.

Visual and verbal data are considered together in this study as 'texts', however it is recognised that spoken words are not drawings. Yet the overarching analysis method for the primary data source of qualitative content analysis remains appropriate as it can be applied to interview data. In Section 3.5 above, it is noted that qualitative content analysis is "a set of techniques for the systematic analysis of texts of many kinds, addressing not only manifest content but also the themes and core ideas found in texts as primary content" (Drisko & Maschi, 2015, p. 82). The flexible nature of qualitative content analysis (Schreier, 2014) enables coding of themes and core ideas in a systematic manner. In Section 3.5.2, it is noted that the systematic qualitative content analysis of concept maps was specifically targeted towards identifying,

- Concepts
- Relationships
- Propositions

This is consistent with the framework for analysing concept maps. When analysing drawn responses, a manual method of transparent overlay was used to identify concepts, relationships, and propositions, which were then tabulated and arranged into themes. Whilst verbal data are not suitable for the same procedure, a complementary 'systematic' procedure is required to support the initial content analysis of concepts maps. Given that qualitative content analysis can enable concepts, relationships, and propositions to be arranged into themes for analysis, examination of interview transcripts could ascertain whether similar or additional themes can be identified in interview data. A line-by-line approach was taken to interview transcripts, whereby text was highlighted using the same colour codes as for concept maps (see Chapter 3.7 Data Reduction). The following studies provide context for how interview data have yielded themes for analysis in education research.

In a study by Martin-Denham (2021), semi-structured interviews were used to analyse responses from 46 head teachers from schools in the Northeast of England. The study examined the impact of exclusion on children's mental health. The author notes the wide use of thematic analysis in qualitative analysis and cites Braun and Clarke (2006, p. 79) who describe thematic analysis as "a method for identifying, analysing and reporting patterns (themes) within data". The researcher chose this approach due to its similarities with qualitative content analysis and grounded theory, and for its use in "exploration of a specific question yet to be analysed and reported" (Martin-Denham, 2021, p. 379). Martin-Denham (2021, p. 380) notes that the data-driven approach proposed by Braun and Clarke (2006) "allowed for the coding of the data without any pre-existing coding framework or the researcher's analytic preconceptions". The current study differs at this point in that the framework of concepts, relationships and propositions has already been established within concept map analysis.

Martin-Denham (2021) transcribed and reduced the recorded interviews and the data were tabulated in Microsoft Excel, where “line-by-line coding allowed for codes pertinent to the research question” to be identified (p. 381). A notable artefact was produced as a result of the tabulated coding in the form of a diagram of similar morphology to a concept map shown in Figure 3.

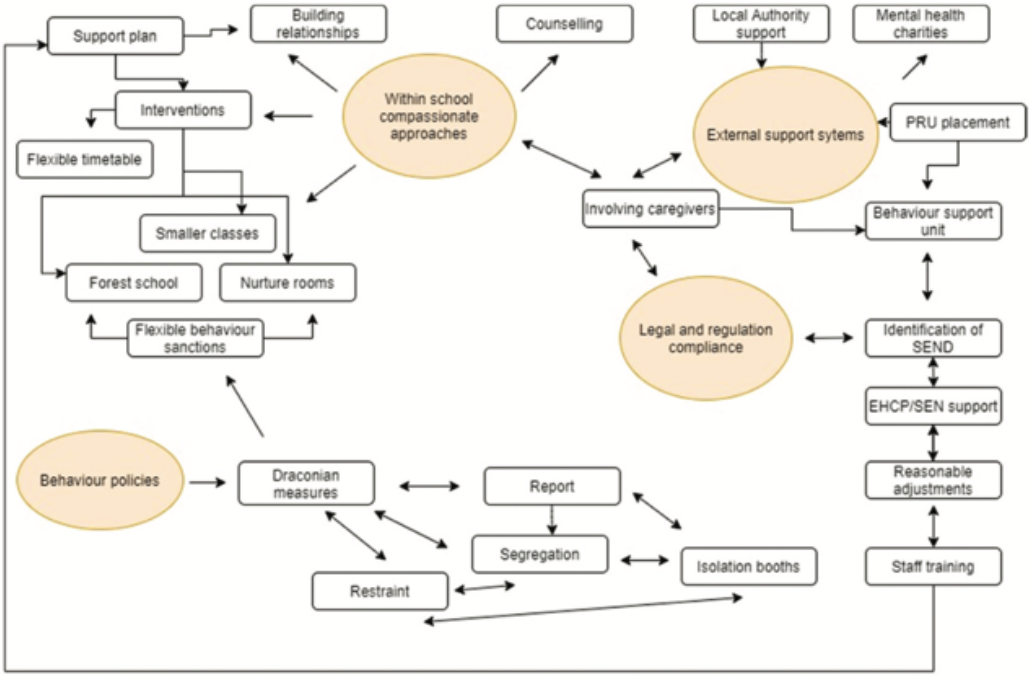


Figure 3 Theme representation reflecting concept map morphology, Martin-Denham (2021)

This example indicates a reciprocal relationship between visual and verbal texts. Themes were identified in verbal texts that could be represented visually. The example also further supports the claim by Bell (2001, p. 15) that content in a content analysis may be “visual, verbal, graphic, oral – indeed any kind of meaningful visual/verbal information”. In the current study, visual data led to further oral data, and in the Martin-Denham (2021) study, interview data could be represented visually. In both cases, meaningful information could be extracted from the data and arranged into themes for analysis.

A study by Porter et al. (2022) investigated teachers’ professional agency and emotions during the COVID-19 pandemic. The study was located in Scottish secondary schools and involved semi-structured interviews with thirteen teachers. The authors chose thematic analysis as it aligned to their approach of a “broadly constructivist research paradigm using grounded theory” (Porter et al., 2022, p. 4). Interviews were conducted individually, transcribed, anonymised, and analysed with NVivo qualitative analysis software. The study differs to that of Martin-Denham (2021) in that it divided the two categories of investigation into deductive and inductive

investigation: agency was considered deductively, and emotions were considered inductively. This exemplifies the flexible application of a method within the broader context of qualitative content analysis. This does not suggest that approaches can be randomly selected. Rather that it allows the researcher to narrow the target of investigation in qualitative analysis. Or as previously noted by Schreier (2014, para. 2), to "focus on selected aspects of meaning, namely those aspects that relate to the overall research question". The researchers acknowledge that the method proposed by Braun and Clarke (2006) was originally described in the context of psychological research. However Braun and Clarke (2006) also acknowledge the wider use of thematic analysis in other research contexts. The relationship pertinent to this study is that concept maps are typically used to assess for knowledge, however wider application is also accepted (Novak, 1995).

In a context much closer to research in this thesis, Holmegaard et al. (2014) consider the perceptions of STEM held by upper secondary school students in a Danish longitudinal study. The study "focuses on students who held a STEM subject as one of their favourite subjects at secondary educational level, but who chose not to study STEM at tertiary level" (Holmegaard et al., 2014, p. 186). The inclusion of the study is pertinent at this point in the discussion as it introduces the concept of value, and what proposition STEM holds for students as they continue their education. The Holmegaard et al. (2014) study resonates with the study reported on in this thesis as it refers to a subject choice and the perceptions created or formed as a result of experiencing that subject. The perceptions collected are not considered in terms of taking a different subject as a result of considering the experiences of students in another subject. Rather, the "analysis explores the students' expectations of what higher education STEM might be like" (Holmegaard et al., 2014, p. 186). That is, the likelihood of those students continuing to study a STEM discipline at tertiary level based on their secondary STEM experience. Holmegaard et al. (2014) conducted narrative interviews to "focus on how individuals make meaning of the world and relate themselves to it" (p. 190). Note the language used by the researchers:

> We do not claim that we by interviewing students map the whole of their identity. Rather through interviewing students about their choices, we learn about how they ascribe meaning to their surrounding world and how they relate to it.
> (Holmegaard et al., 2014, p. 190)

The notion that the line of enquiry would create a 'map' of student identity based on student 'choices' bears strong resemblance to the current study. Yet there is a distinct difference as noted above. Holmegaard et al. (2014) are not comparing different subjects, or value propositions offered by disparate subjects. Nor did they consider visual data. However, their use of interviews in data collection enabled the identification of themes which informed the research question.

Holmegaard et al. (2014) used thematic analysis (Braun & Clarke, 2006) to identify themes within the data. As it was a longitudinal study, the researchers were able to structure their analysis into two parts; those students who chose not to study STEM at higher education despite STEM being a favourite subject in secondary school. And those students who did continue to study a STEM discipline at tertiary level. A similar approach could have been used in the study in this thesis in that students could have been interviewed again 18 months later at the commencement of their next stage of schooling when subject choices again needed to be made. However, the time required for this approach and the uncertainties surrounding the impacts of the COVID-19 pandemic and access to schools would have made this approach to unreliable.

A comprehensive review of the Holmegaard et al. (2014) study is beyond the scope of this discussion. However, the high-level results do contribute to the relevance of themes within interview data. The researchers uncovered that the students interviewed made choices about their continued study based on their desired future identity. Those who chose not to pursue STEM described the field as too rigid with “rigorous methods and strict rules and procedures that the students had to obey, and with very little room for influencing the content or teaching formats” (Holmegaard et al., 2014, p. 210). Conversely, those that did choose to continue with STEM found those characteristics desirable for forming self-identity. Noteworthy and relevant to the current investigation is that choices were made based on perceived value beyond the actual discipline itself. That is, the discipline would influence the development of themselves as individuals, and that this impact was identifiable. Such insight relates to the objectives of ‘inclination’ and ‘understanding’ in this study, whereby students make a value judgement about an alternative course of action based on the perceptions and value judgements of others.

In a smaller-scale study investigating value perception, Harrison et al. (2019) conducted semi-structured interviews with ten Chinese adolescents in a Hong Kong private secondary school. The students were enrolled in a school-based mentoring program. The purpose of the study was to “identify aspects of the mentoring process and relationships which the mentees find beneficial” (Harrison et al., 2019, p. 150); essentially a question of value. Whereas the study in this thesis used an opt-in approach to participation, the researchers used purposive sampling “to recruit students with a range of reasons for referral into the mentoring programme” (Harrison et al., 2019, p. 151). Interviews were recorded and transcribed, and NVivo 11 was used to assist with coding. The researchers identified themes (Braun & Clarke, 2006) and cite Maxwell (2012) in their use of a critical realist framework. The researchers note the use of thematic analysis enabled them “to triangulate meaning across a number of participants (Braun & Clarke, 2012) and so to develop an overview of the ways in which mentoring is considered helpful to mentees” (Harrison et al., 2019, p. 151). After initial codes and themes were developed by the first author, further refinement took place in discussions with other authors.

Similar to previously mentioned studies, the authors used extracts from the interviews to describe the themes identified. In addition, the results were represented diagrammatically in a 'thematic map' shown in Fig. 4.

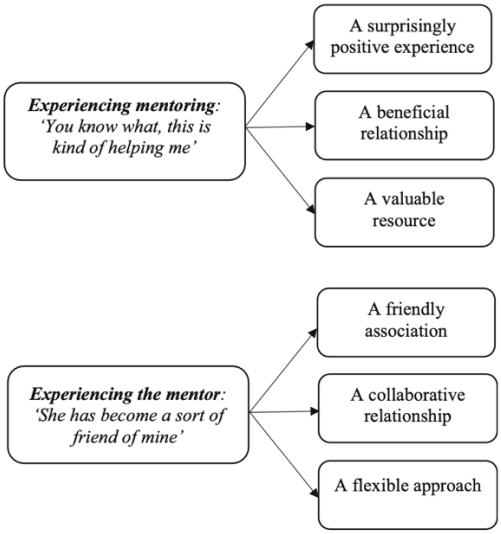


Figure 4 Thematic Map, Harrison et al. (2019)

Harrison et al. (2019) do not indicate that it was their intention to create visual data from verbal data. However, there is the possibility of visual representation given that themes identified are distinct enough to be displayed diagrammatically.

In some cases, interviews are not transcribed from an audio recording. In a longitudinal study involving twelve secondary teachers in Sweden, Fägerstam (2014, p. 60) took notes during interviews and "the interviews were recalled and transcribed on the basis of these notes". Like the interviews conducted in this thesis, the duration was 30-60min. The study investigated teacher perceptions of the educational potential of regular school-based outdoor learning based on one year's experience. The study also sought to uncover if perceptions changed after the teachers' one year experience. Fägerstam (2014) conducted a longitudinal study where there was a 'before and after' component to the data collection. That is, there was a consideration of whether perceptions had changed based on an experience of outdoor learning. Whilst the study in this thesis is not longitudinal, there is also a 'before and after' component in that there are two 'Phases' of data collection. Phase 1 collects initial conceptualisations, and Phase 2 collects further conceptualisations based on new stimulus material and compares the results with Phase 1.

Fägerstam (2014) makes no indication of software-assisted coding in the analysis. Data are summarised in tables as text indicating themes and sub-themes, and differing perceptions pre and post outdoor teaching interviews. This is similar to the method used in concept map

analysis and data reduction in this thesis. It suggests that the same approach from qualitative content analysis of concept maps could be used to tabulate themes from the interviews conducted for this thesis.

A study by Brink et al. (2022) investigates teachers' experience of teaching digital models. The researchers describe the study as taking a "phenomenological lifeworld approach" (p. 1755) (citing Bengtsson (2013)) in which data are analysed thematically to produce "themes of experiencing the teaching of digital models" (Brink et al., 2022, p. 1755). The study took place in a Swedish lower secondary school context and involved semi-structured interviews with 12 teachers. Whilst the study interviewed teachers, the students of those teachers were year 7-9 students which were of similar age to those reported in this thesis. The researchers state that "semi-structured interviews were chosen to correspond to the ontological assumption and aim" of the study (Brink et al., 2022, p. 1760). Moreover, that teachers would be able to express their experience of teaching digital models (the phenomenon) from their point of view. Whilst the focus of the study was 'digital' models, teachers were selected from different backgrounds "to cover the wide spectrum of teachers in service, concerning gender, teaching experience, and the size of the school" (Brink et al., 2022, p. 1760). All participants were formally trained teachers, although not specifically trained in digital technologies or curriculum, despite being technology teachers. Interviews are described as "open in character" (Brink et al., 2022, p. 1760) although stimulus questions were used to provide guidance and some level of focus. It is noteworthy that the researchers describe the interviews as 'semi-structured', and 'open in character', and also provide a list of questions for guidance. This suggests an element of structure with a great amount of flexibility. As stated in section 3.4.2 of this thesis, semi-structured interviews were considered necessary for a similar reason of focus, particularly since participants were students.

In their 'synthesis' of the data, Brink et al. (2022) also include a tabulated / diagrammatic representation of the data. This further indicates that themes shown in tabulated words, or extracts of interviews, are not mutually exclusive from visual/graphical representation of concept map analysis. Figure 5 below demonstrates how Brink et al. (2022, p. 1767) defined and tabulated the themes, and how this leads to visual connections in the form of a Venn diagram.

Themes – aim of teaching digital model	Teaching aspects– teaching content and/or methods
Enhancing and integrating other subjects	Mathematical concepts Generating data for mathematical analysis Preparations for crafts
Visualizing technology to the pupils	Concretize technology Basis for discussions
Enabling digital modelling	Iterative process Handling software Physical objects
Preparing pupils for the future	Technological education programmes Technological professions General technological knowledge

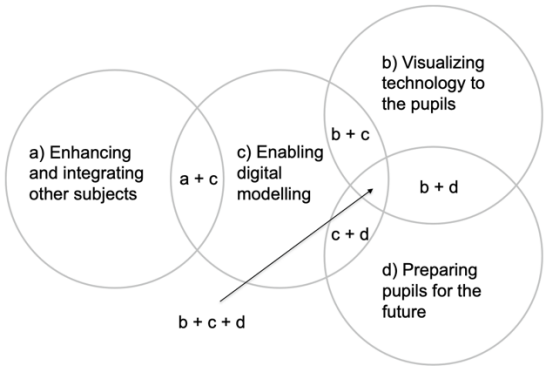


Figure 5 Digital Models, Brink (2021)

They are distinct, yet complementary forms of representation. In the context of the study reported in this thesis, potential exists to represent themes (concepts, relationships, propositions) in a similar diagrammatic manner.

A deeper analysis on the research questions and findings of the Brink et al. (2022) study is beyond the scope of this discussion. However, the researchers report two findings which potentially indicate the value of conducting interviews after the generation of concept maps. Firstly, the notion of 'justification'. In the themes identified, the researchers note that teachers express the 'what', 'how' and 'why' of their teaching with digital models. Yet "it seems more important for the interviewed teachers to justify their teaching rather than just to explain it" (Brink et al., 2022, p. 1770). For students generating concept maps, it is acknowledged that graphically representing a justification of thought or action could be challenging. Moreover, that it may be easier to 'say' the justification, or reason behind the concept map. As such, notice is given to whether concept maps contain written statements of justification and whether these are also reflected in interviews. Such statements may indicate the desire to communicate a thought or concept, whilst being difficult to do so. Secondly, Brink et al. (2022, p. 1770) report that "another finding of this study is that digital models are a means for enhancing and integrating other subjects, such as mathematics and crafts". This is not the same as the potential outcome of this study, that a student may take an additional (or different) subject because of its wider appeal. However, there are strong parallels. As Brink et al. (2022, p. 1770) observed, "during the interviews, the examples described by the teachers often point to the learning objectives of

other subjects". Seeing value in a different subject from the perspectives of students in that subject is akin to considering the value of its learning outcomes. Integrating two subjects as a result would seem a possible consideration. The similarity between Brink et al. (2022) and the objectives of this study further suggest the suitability of follow-up interviews to support visual data.

Given the frame of disruptive innovation considered in this thesis, a study by Nielsen (2015) also provides useful insight. The study reports on interviews with 28 teachers across 5 schools in the Capitol Region in Denmark. The aim was to assess students' innovation competency. The research presented in this thesis does not investigate whether students would be capable of approaching their subject choices innovatively, nor whether they see their subjects as 'innovative'. However Nielsen (2015) raises a pertinent question which could open a potential line of enquiry, as to whether students would see disparate subjects as having 'disruptive' value. Moreover, whether a perception of disruptive value may be related to their innovation competency.

The Nielsen (2015) study was project-based, running over three years, in which the organisation and teaching of one class was "fundamentally changed" (p. 319). Success criteria were used to determine whether there was any difference in innovation competency between the participating and non-participating classes. Similar to the study by Brink et al. (2022), one of the success criteria was whether there was also a corresponding increase in motivation and satisfaction. The parallel that can be drawn is that 'satisfaction' implies 'value', or that students who found the changes satisfying also considered the experience valuable. An argument could be made that interview analysis to investigate satisfaction this way is too simplistic or reductionist. For example, a student may simply respond by saying that the experience was valuable. However, the aforementioned studies indicate that themes within interview data can indeed elicit deeper meaning.

A range of groups were interviewed including teachers and students, and classroom lessons were observed, although only the interviews with teachers were reported on. A three-step process was used in conducting interviews:

1. Teachers within each school group were interviewed.
2. An "initial sketch of the construct in the form of a list of potential signs of a student having innovation competency" was "designed".
3. A further interview was carried out in which the researcher engaged teachers in "structured discussion activities" during which the "teachers' talk and interaction during those activities was audio-recorded and transcribed".

(Nielsen, 2015, p. 320)

Step 2 (above) was used as stimulus material for the discussion activities in step 3. A distinct point of similarity to the Nielsen (2015) study, and the study in this thesis, is that the teachers were "specifically asked to add signs to, and, if appropriate, reformulate signs on, the initial list of signs" (Nielsen, 2015, p. 320). This echoes the Phase 1/ Phase 2 approach used in this study, where Phase 2 concept maps and interviews provided opportunity for students to build upon their conceptualisations of their chosen subjects based on conceptualisations of other students.

Nielsen (2015) employed thematic analysis (Braun & Clarke, 2006) and kept the analysis "as regimented as possible" (p. 321). There is no reference to qualitative analysis software being used in the process. The results were coded in a manner similar to this thesis in that the five schools were listed A – E and the quotations, or extracts from interviews numbered (e.g. A01, 199: where A = school, 01 = teacher, 199 = quotation). This method was considered appropriate to generate five sub-competencies under the broader umbrella of 'innovation competency'. These were identified as "creative, collaboration, navigation, action and communication competency" (Nielsen, 2015, p. 322).

Of these 5 sub-competencies, two that could potentially draw even closer links with the study in this thesis are 'navigation' and 'communication'. The concept of 'navigation' may inform the primary research question in this thesis of how students conceptualise the technology / STEM / languages they study. Noting the findings by Holmlund et al. (2018) discussed in the introduction (Chapter 1), the multiple conceptualisations that students have of STEM subjects requires a knowledge of, or competency in 'navigating' the multiple disciplines within STEM (and by inference, technology). This relates to findings by Nielsen (2015) that suggest navigation competency is the ability for students to "functionally handle knowledge" and "to cope with complex, dense, or chaotic information when working with a problem or issue" (Nielsen, 2015, p. 324). Whilst Nielsen (2015) was not investigating STEM specifically, the findings between the two studies resonate. 'Communication' competency bears a similar resemblance in that teachers argued for the ability of students "to assess a communication situation, and, on the other hand, the ability to make informed decisions about communication" (Nielsen, 2015, p. 325). Specific techniques of communication, and the ability to be engaging and convincing in communication were also identified as required competencies. Given that 'value perception' is a concept underlying the primary research question in this thesis, the notion of communication becomes pertinent. For if a student is to make sense of their conceptualisation and value of a subject, then in the first instance they are communicating it to themselves.

The Nielsen (2015) study creates noteworthy links to the underlying questions in this thesis. However, the contribution the study makes to this discussion is the indication by the researcher that interviews enabled the identification of usable data that could be arranged into themes. Nielsen (2015) notes in conclusion that "the data showed that the sample teachers were able to

give very rich descriptions", and "found it meaningful to talk about innovation competency" (p. 328). Moreover, that teachers' talk "provides a very detailed glimpse into how assessment of innovation competency could take place in the context of upper secondary education" (Nielsen, 2015, p. 328).

Studies in this section illustrate the flexibility and varied use of interviews in education contexts. Papers discussed frequently cite the work of Braun and Clarke (2006) who employ thematic analysis from the research context of qualitative psychology when analysing interviews. Whilst this study is specifically in the education context, the studies discussed thus far acknowledge thematic analysis to be a flexible method in its own right for interview analysis, and appropriate for wide use (Braun & Clarke, 2006). However as previously stated, this study is not a mixed methods study. Rather it employs the two strategies of visual and verbal data collection. The contribution these studies bring to bear on this discussion is the nature in which themes can be identified in interview data that further support the visually drawn participant responses. The underlying frame of 'concepts', 'relationships', and 'propositions' as applied to the primary data source will therefore be applied to interview transcripts to ensure that participant responses are analysed wholly and consistently. The techniques used to verify, reduce, and analyse the data are now discussed.

3.6 Data Verification

Section 3.5 outlines methods for qualitative content analysis of concept maps and follow-up interviews. Previous studies employing analysis of visual and verbal data in education research are discussed to provide context for this study. Acknowledgement is made of the importance of verification in qualitative data (Denscombe, 2007) for the findings discussed in Chapter 4.0 Findings to be considered credible. The following sections address data verification in terms of validity, reliability, generalisability, and objectivity as they pertain to the study. The discussion creates a basis for data reduction (Section 3.7) and subsequent documentation of findings in Chapter 4.

3.6.1 Validity

In this study, the primary data collection method was via visual methods. Participants were provided with instructions and stimulus material to produce concept maps for the purposes of establishing conceptualisation and propositions about the subjects they were studying. Data were considered to be 'valid' if the data collection instrument could be accurately and precisely responded to and provide responses that appeared consistent with the data collection method (Denscombe, 2007). Accuracy and precision were considered to be achieved if participants

were able to respond to what Novak (1995) describes as ‘focus questions’ and then produce a concept map of similar morphology to the samples provided in stimulus material.

Two examples of concept maps were provided to participants. The first was a conceptual outline of what a concept map looks like and how it is structured, shown in Figure 6.

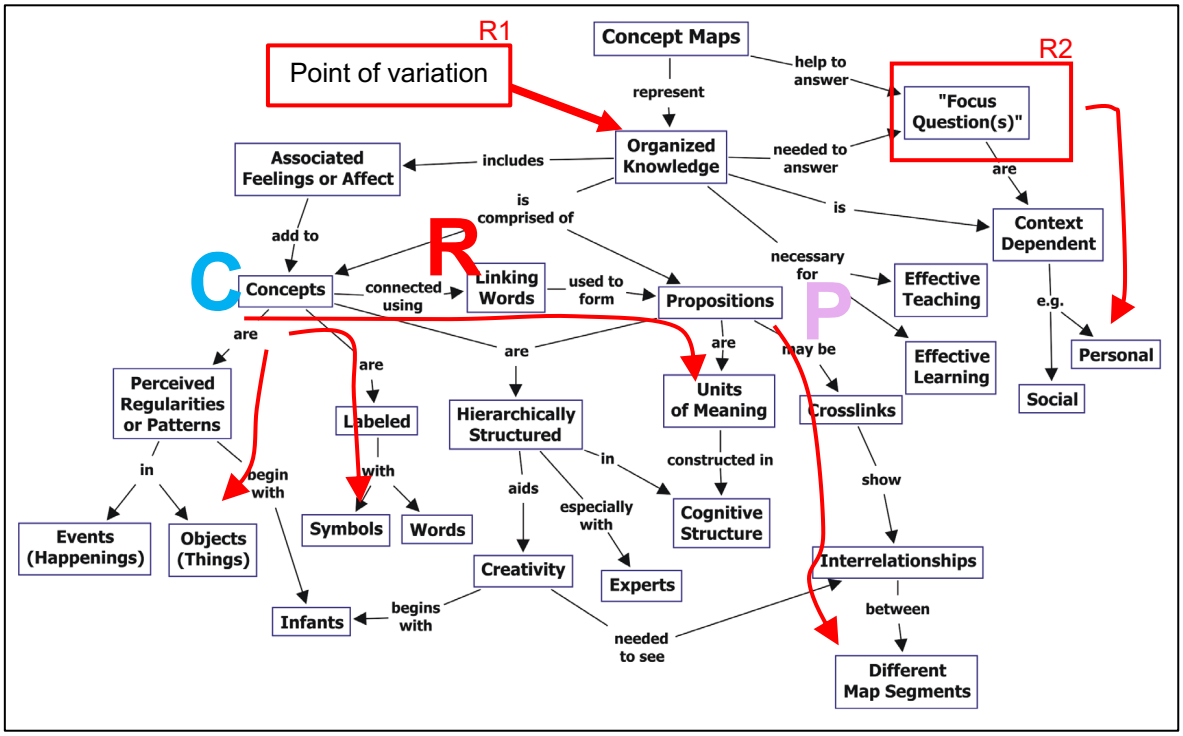


Figure 6 Conceptual outline of concept map structure (Novak, 2008)

Figure 6 describes the structure of concept maps and how the elements fit together. It is superimposed with rectangles R1 and R2, and labels ‘C’ (concept), ‘R’ (relationship), and ‘P’ (proposition) which indicate how concept maps have been used in this study. Red lines/arrows are also superimposed to show how concepts, relationships, and propositions are linked. The labels ‘C’, ‘R’, and ‘P’ were used in concept map ‘overlays’ (described in Section 3.7.1) to identify where concepts, relationships, and propositions occurred in participant responses. The concept map in Figure 6 was provided as a sample to participants without the superimposed elements.

R1 notes a point of variation for the use of concept maps in this study. Concept maps are typically used to represent or assess knowledge (Novak, 1995), indicated in Figure 6 as ‘Organised Knowledge’. Note that in Figure 6, organised knowledge leads to ‘effective teaching’ and ‘effective learning’. In this study, the research questions centred around conceptualisation and value perception. Participants were not being assessed on their ‘organised knowledge’ of the subjects but were asked to ‘conceptualise’ their subjects independently of the curriculum. Participants responded to ‘focus questions’ as indicated by R2 in Figure 6 above. Focus

questions are ‘context-dependent’, in this case reflecting how Technology/STEM and Languages subjects are perceived and conceptualised in the research sites (schools) chosen.

The labels ‘C’, ‘R’, and ‘P’ are the focus of data collection in this study. The labels indicate how concepts may be identified; how relationships between elements may arise; and how propositions (units of meaning) can proceed from the interrelationships of connected elements. Concepts may appear as words or symbols, and in this study also as groups of words. Relationships were identified as linking words, or elements joined together with arrows or arranged in visual hierarchy. Propositions were identified as statements, groups of words, or short sentences that conveyed specific meaning (Novak, 1995) (discussed further in Chapter 3.8.1).

The researcher applied this technique of identifying concepts, relationships, and propositions consistently to all responses across each of the research sites. The technique was conducted manually and is described further in Chapter 3.7.1.

The second concept map provided as stimulus to participants was a typical concept map used for assessing knowledge using the subject of Photosynthesis, shown in Figure 7 below.

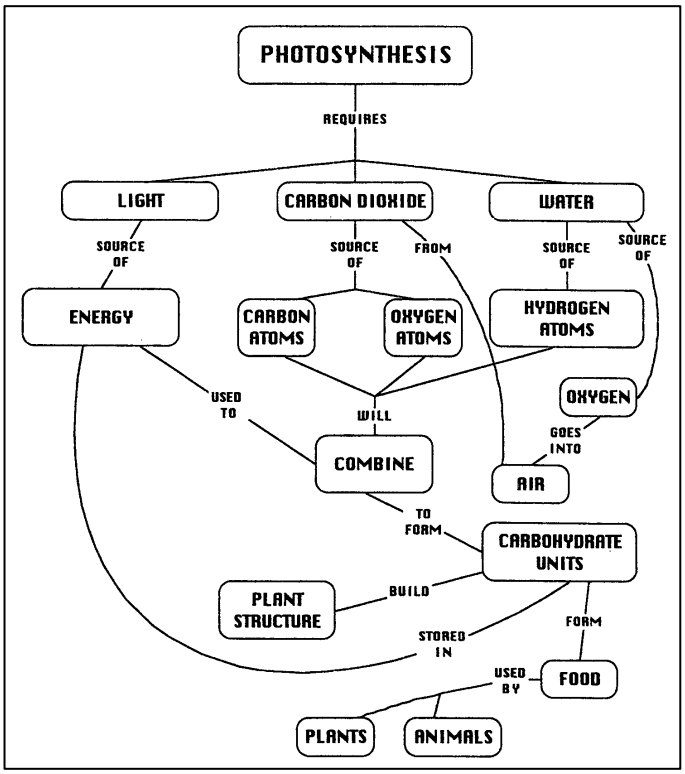


Figure 7 Typical concept map for assessing knowledge (Novak, 1995)

Together, the concept map samples provided participants with a basis from which to begin drawing their responses. Participants were instructed that they were producing a known form of

data collection that was similar to, but distinct from other visual ‘maps’ they may have created such as ‘mind maps’ or ‘brainstorms’. As with the study by Holmlund et al. (2018), participants were also permitted flexibility to move beyond the typical example as the literature suggests that there are multiple conceptualisations of STEM, and by inference in this study, technology subjects; see sections 1.1.1 and 1.1.2. See also Bybee (2010), Baillie and Metzger (2013), Baker and Galanti (2017), Laforce et al. (2016), and Merrill (2009). The same flexibility was provided to languages participants. The appropriateness of concept map data was validated by similar studies discussed in Chapter 3.5 Data Analysis. Investigation into studies employing interview methods also revealed visual analysis methods similar to concept maps being used in conjunction with interviews (Martin-Denham, 2021), as was done in this study.

Representative samples from Schools A, B, and C are provided below for Phase 1 and Phase 2 data collection. An inset is shown between samples for easy visual comparison of the morphology of participant responses to the stimulus material provided.

School A

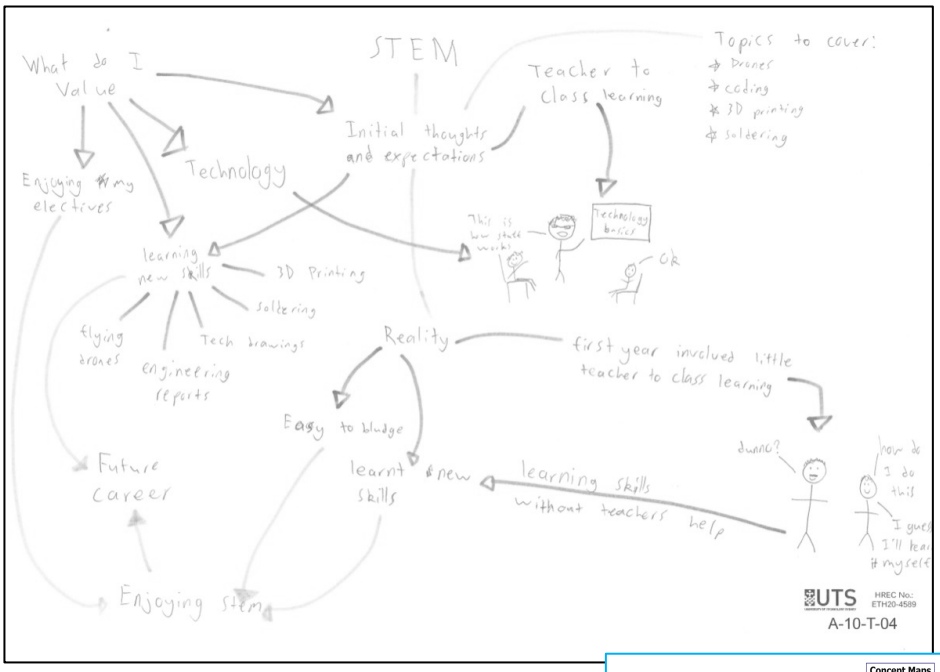
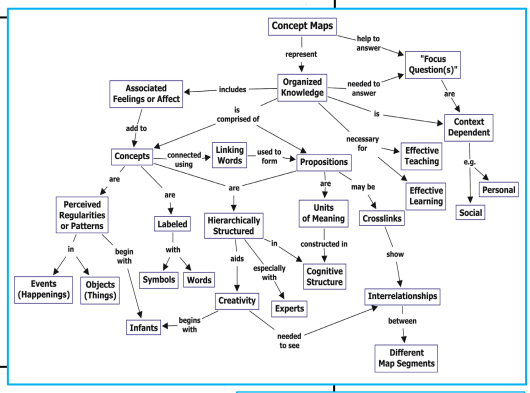


Figure 8 School A Phase 1 Concept Map (Technology) - Validity Sample



Inset: Figures 8 & 9

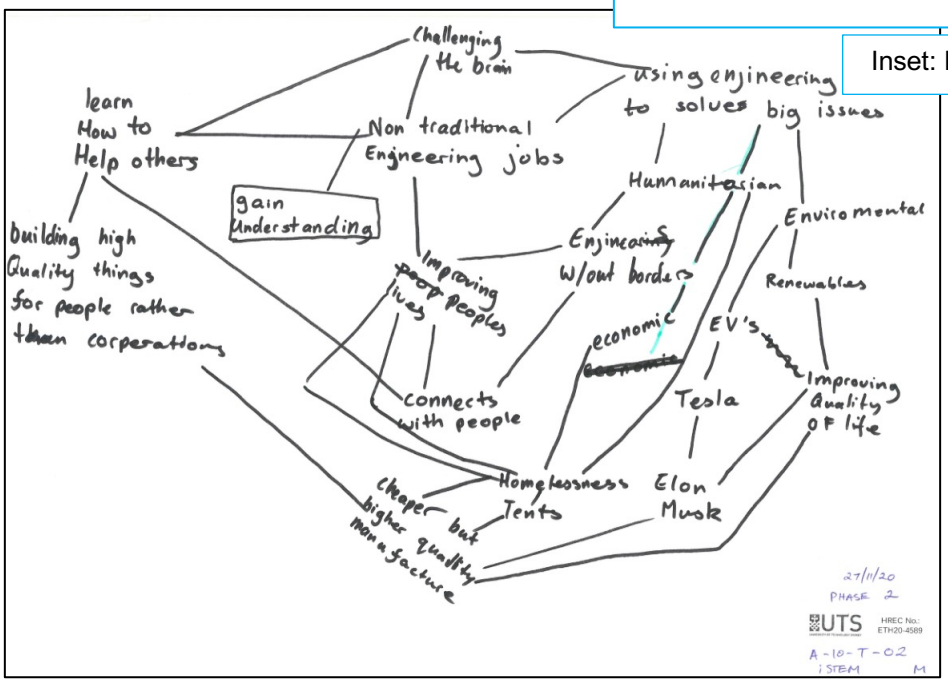
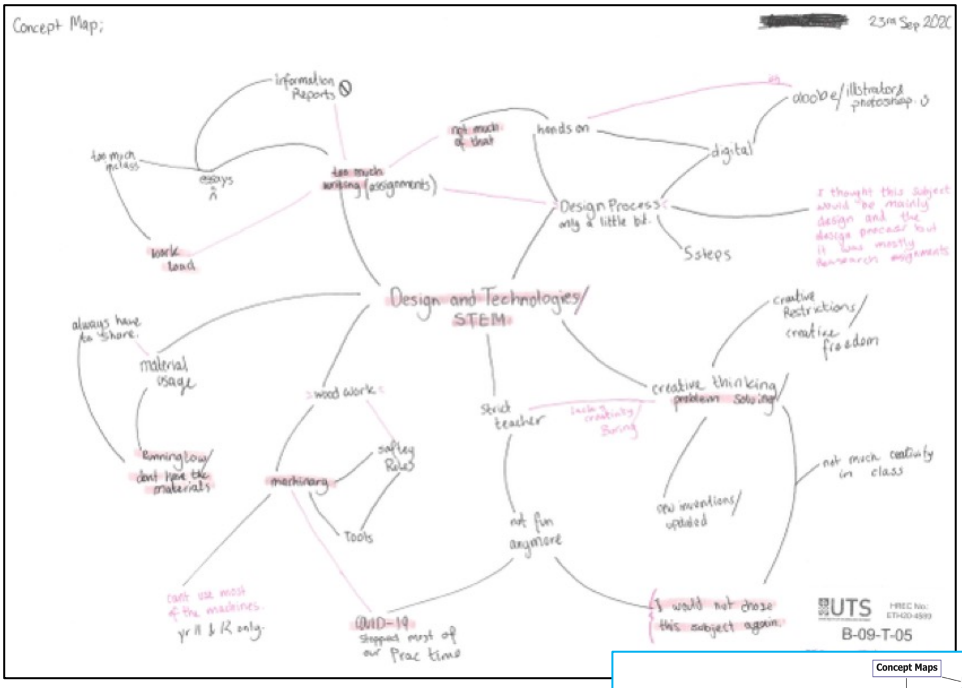
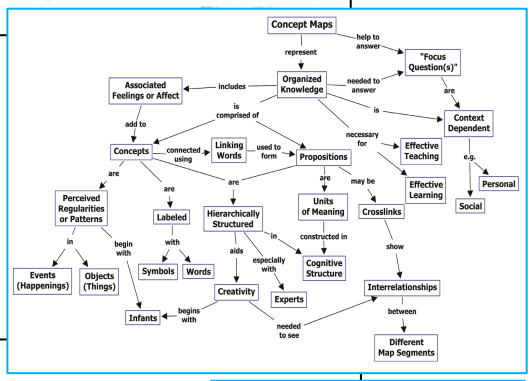


Figure 9 School A Phase 2 Concept Map (Technology) - Validity Sample

School B





Inset: Figures 10 & 11

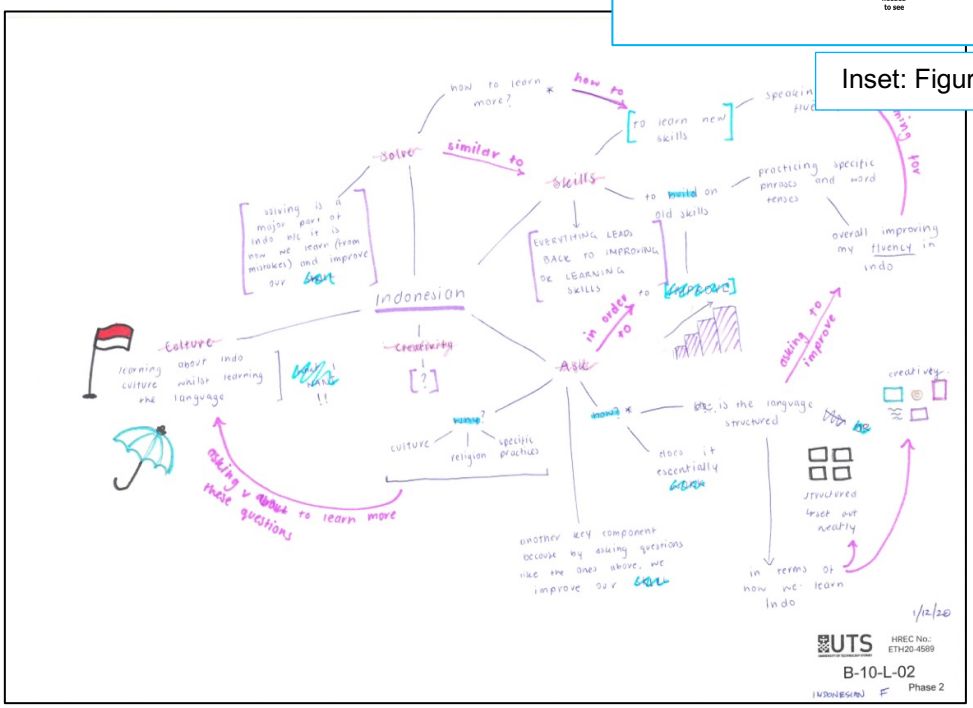


Figure 10 School B Phase 1 Concept Map (Technology) Validity Sample

Figure 11 School B Phase 2 Concept Map (Languages) - Validity Sample

School C

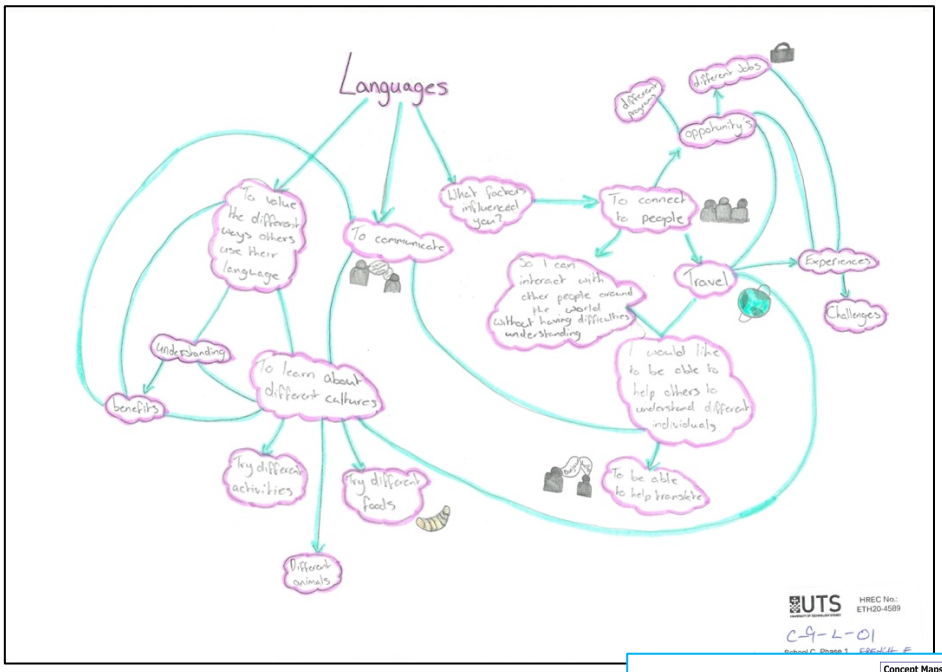
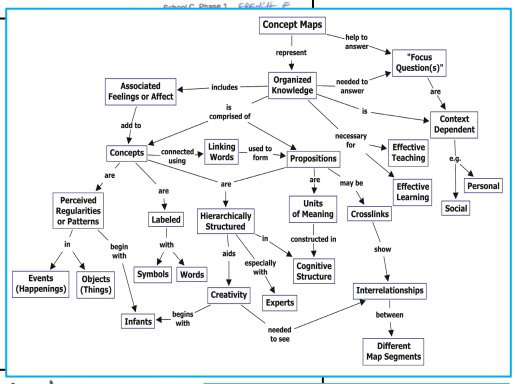


Figure 12 School C Phase 1 Concept Map (Languages) Validity Sample



Inset: Figure 12 & 13

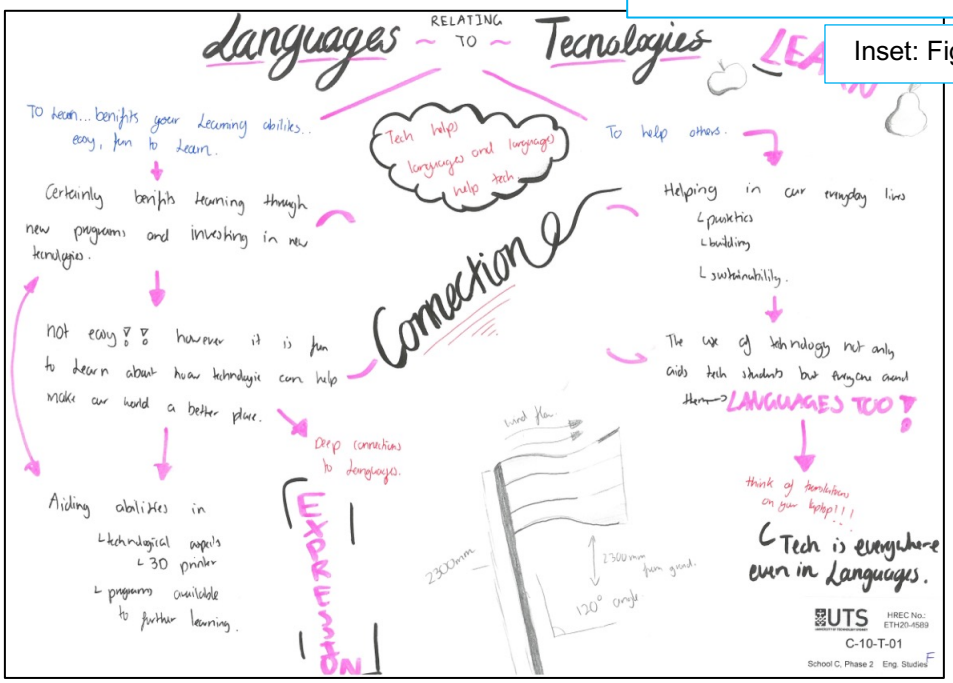


Figure 13 School C Phase 2 Concept Map (Technology) - Validity Sample

The representative samples for Schools A, B, and C above illustrate broad alignment in morphology with the sample provided to participants. For each school, samples for Phase 1 and Phase 2 are shown to indicate that participants were able to provide accurate responses to the data collection task on the first attempt. The concept maps did not become 'more accurate' in Phase 2 data collection. A variation is noted in Figure 13 (School C Phase 2) in which the concept map shows less formal structure in the use of linework and is more dependent on words and short sentences to convey information. However clear linkages remain with the use of different-sized text to convey high-level concepts, arrows to link elements to form 'relationships', and short sentences to convey propositions. Further details on how concept maps were broken down are explored in Chapter 4 Findings. At the commencement of sub-sections discussing findings at each school, examples of concept map data are provided to illustrate how participants were able to respond to focus questions and produce concept maps in accordance with the task. The overall consistency of morphology noted across the three research sites supports the validity of the data collected using this method for this study.

3.6.2 Reliability

As noted above, participants across the three research sites produced responses which demonstrated consistency with the stated method. Since the concept maps were not used for assessment of correctness, each response was considered individually for conceptualisation and value perception. Whilst there was high-level consistency across the schools, there was some variation in that several responses were visually striking and others much less so. Visual impact was not a measure of correctness in the study, nor was it treated as more or less valuable. Each response was considered impartially with respect to the frame of concepts, relationships, and propositions for the purposes of addressing the research questions. The distinction between responses of high visual impact and those of simpler presentation are discussed in the context of findings in Chapter 4. Two examples are shown here to illustrate the difference.

Figure 14 below illustrates a response of high visual impact. The concept map is evenly laid out with colours used to distinguish between elements such as arrows/lines and highlighted text. The concept map contains sketches to help communicate aspects of the response. The sketches indicate a level of care and creativity.

Figure 15 below indicates a simpler response with less visual impact. Only one colour is used, and the morphology is basic by comparison with Figure 14. No sketches are included on the concept map. Differences in visual impact notwithstanding, both Figure 14 and Figure 15 present responses in which concepts, relationships and propositions can be identified and are thus reliable for the purposes of the study.

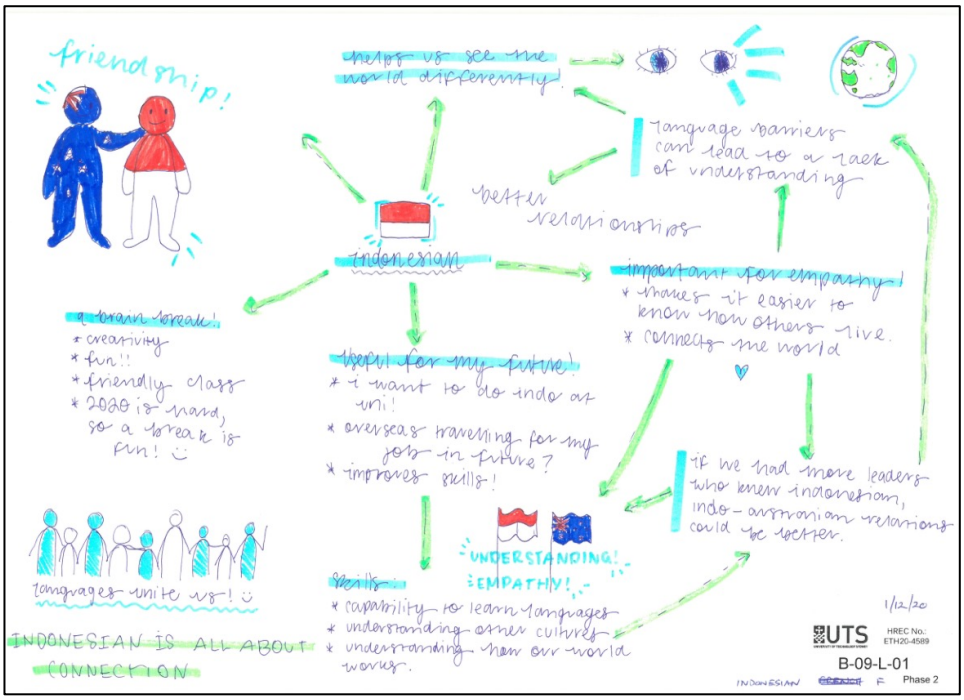


Figure 14 High visual impact sample - School B Phase 2 Languages

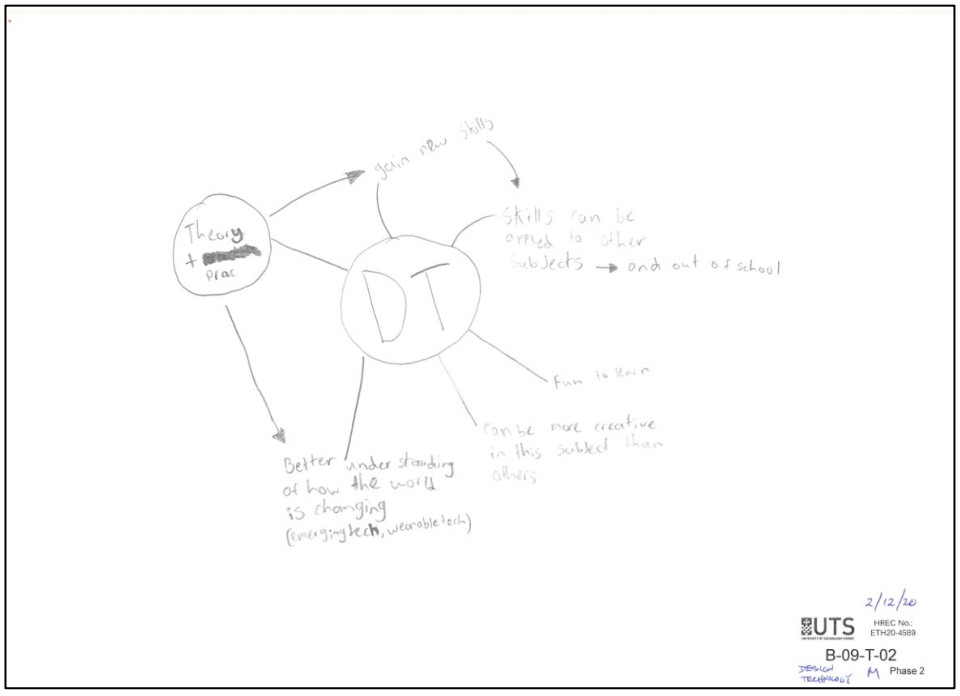


Figure 15 Lower visual impact sample - School B Phase 2 Technology

As Denscombe (2007) states, reliability is considered by “whether a research instrument is neutral in its effect and consistent across multiple occasions of its use” (p. 296). The three schools used in this study are similar in socio-economic demographic and type (independent coeducational, K-12 Christian schools) yet are widely separated geographically and by state

(two in New South Wales, one in the Australian Capital Territory). The outcomes produced by participants support the reliability of data in this study. Sub-sections in Chapters 4.2, 4.3, 4.4 provide further examples that illustrate this reliability in the context of documenting findings.

3.6.3 Generalisability

The study does not attempt to generalise findings or assume that participants in any given situation would respond as those did in the schools used. Rather, the study aims to uncover individual conceptualisation and value perception as the lived experience of each participant. This resonates with the study by Holmlund et al. (2018) where individual responses could inform teacher approaches within each unique context, rather than being universally applied. Coupled with the 'non-assessable' use of concept maps in this study, each response was therefore considered on its own merits as it was presented to the researcher, and then considered collectively within the context of other participants at the school. This is consistent with the 'context-dependent' nature of focus questions in concept map usage, as reflected in Figure 16 below. As previously stated, in this case the context revolves around how Technology/STEM and Languages subjects are perceived and conceptualised in the research sites (schools) chosen. The same focus questions were presented to each school for Phase 1, and Phase 2 focus questions were developed from responses within each context.

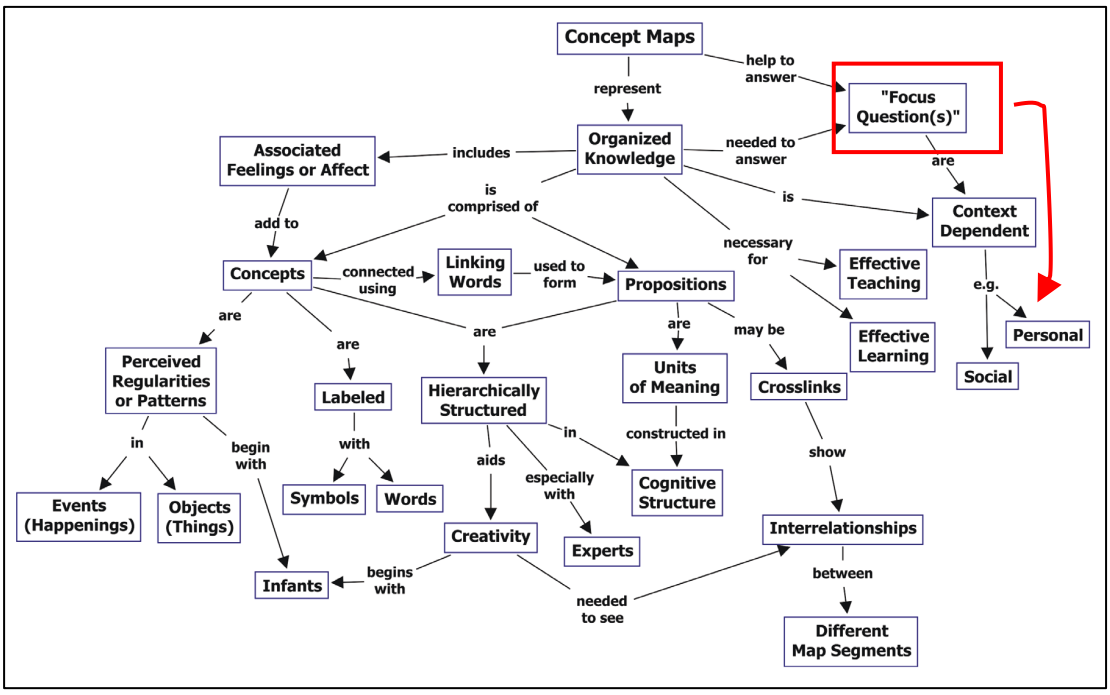


Figure 16 Context-dependent nature of focus questions in concept maps (Novak, 1995)

For these reasons it was not deemed necessary to use any kind of control group or interrater analysis in the consideration of findings. For teachers using findings from this study and employing the methods used, the data would present to them in their own context in the same

way as the data were presented to the researcher. This would be unique in any given context. Teachers could share findings with teachers in other contexts, however the findings may not be applicable across contexts.

3.6.4 Objectivity

The foreword in Section 4.1 is provided in recognition of the notion of the researcher's self. As Denscombe (2007, p. 301) states, "there is a growing acceptance among those involved in qualitative data analysis that some biographical details about the researcher warrant inclusion as part of the analysis". The foreword describes the genesis of the study and identifies the researcher as a character in the wider story being investigated. The presence of self in the study is therefore duly declared. That presence notwithstanding, processes were put in place to minimise or avoid the influence of bias in the creation of data and interpretation of findings. Concept maps were produced individually by participants without researcher involvement. The researcher explained the task to participants and provided stimulus material in the form of sample concept maps and written focus questions. The researcher did not assist participants in the creation of concept maps beyond providing instructions and stimulus material. Follow-up interviews were conducted by the researcher with participants in a group setting. Due to scheduling constraints, it was not possible to separate technology and languages participants in all sessions. Follow-up interviews were conducted in a semi-structured format (see Chapter 3.4.2) as it was considered more appropriate for student participants. This format provided enough guidance to keep student participants focussed on the task whilst minimising the risk of the researcher presenting leading questions. This is verifiable in the researcher's comments and participant responses as found in follow-up interview transcripts. The researcher was the sole interpreter of the findings. However, as noted in the section above (generalisability), this is not considered a hindrance to the findings. The same method for interpretation was applied to both concept maps and follow-up interviews to maintain consistency across data sets. With respect to the objectives of the study, and acknowledgement of the researcher's self in the study, the interpretation of responses produced findings of sufficient objectivity to address each of the research questions.

3.7 Data Reduction

Raw data were collected from 40 student participants and 1 teacher participant in the form of concept maps and follow-up interviews. To prepare the data for analysis, concept maps were scanned, and files stored securely on university cloud storage services. Interviews were transcribed by a professional and secure transcription service. Audio files and PDF copies of

the interview transcripts were stored with the concept map scans in the same location on secure university cloud storage.

Denscombe (2007, pp. 289-290) notes that qualitative data "materials should be collated and organised in a compatible format", that data should be collated in a manner that enables comments and notes to be added easily, and that "material should be identified with a unique serial number for reference purposes". Whilst concept maps were analysed with manual methods using physical overlays over the original concept map (described below), interviews were analysed by digitally 'marking up' PDF transcripts using a PDF reader. Despite one process being manual (analogue), and the other digital, the two processes together formed the most reliable procedure for generating 'familiarity' across the data (Denscombe, 2007). Concept maps were identified by a coded label and interview transcript files were named according to school and interview group.

The coded label for concept maps used the convention outlined below.

Table 6 Concept Map label code

A-10-T-01			
A	10	T	01
School	Year Level	Subject Group	Participant Number

Subject groups:

T: technology subjects

L: languages subjects

The arrangement of data described above adequately prepared the volume of data to be reduced for the identification of themes in accordance with concept map analysis (Chapter 3.5.2). Interview transcripts could then also be reduced using a similar process (Chapter 3.7.2).

3.7.1 Concept map data reduction

The reduction of concept map data used the following four-step process.

1. Transparent overlay placed over the concept map.
2. Using markers, examine the concept map and 'mark up' for concepts, relationships, propositions.
3. Tabulate the identified concepts, relationships, propositions.

4. Reduce tabulated concepts, relationships, and propositions to identify and tabulate themes.

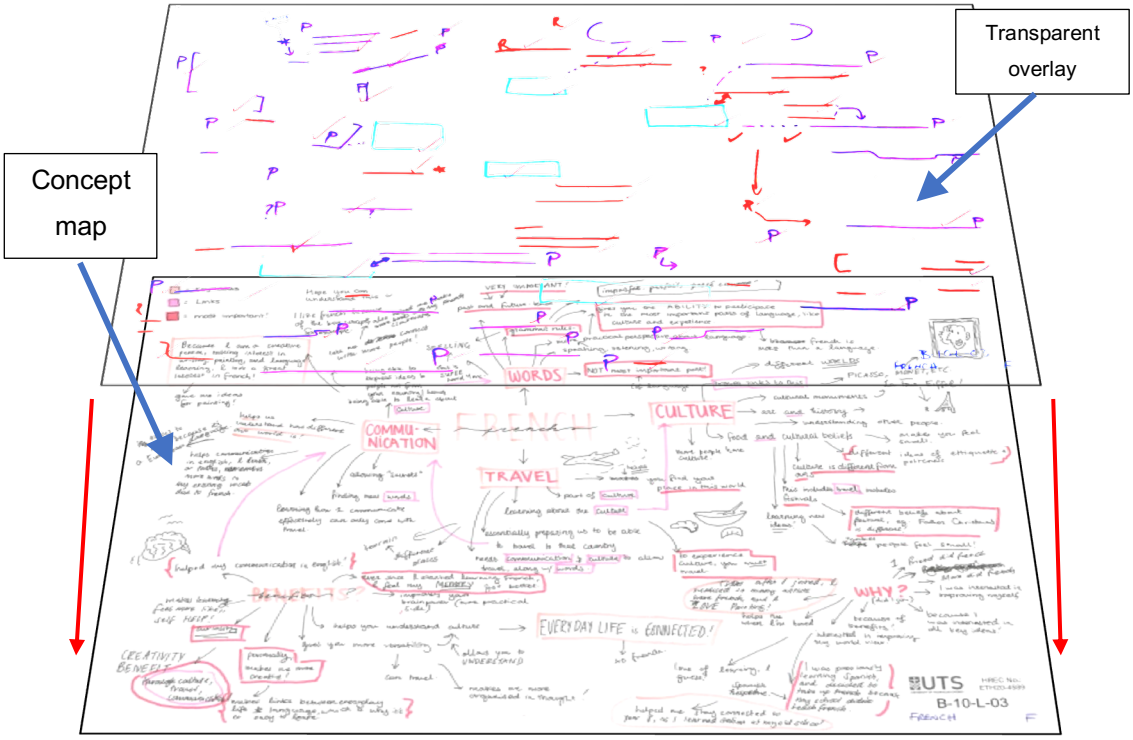
Markups use the following colour coding:
C, Concept, drawn in cyan
R, Relationship, drawn in red
P, Proposition, drawn in purple

A preview of all Phases 1 and 2 concept map data for Schools A, B, and C is provided in the following appendices.

Appendix F - School A, Phase 1 and 2 Concept Maps, Overlays, Data Reduction Tables
Appendix G - School B, Phase 1 and 2 Concept Maps, Overlays, Data Reduction Tables
Appendix H - School C, Phase 1 and 2 Concept Maps, Overlays, Data Reduction Tables

Each concept map is accompanied by the transparent overlay which was used to inspect and markup for concepts, relationships, and propositions.

Steps 1 and 2 of this process are shown graphically in Figure 12 below (next page).



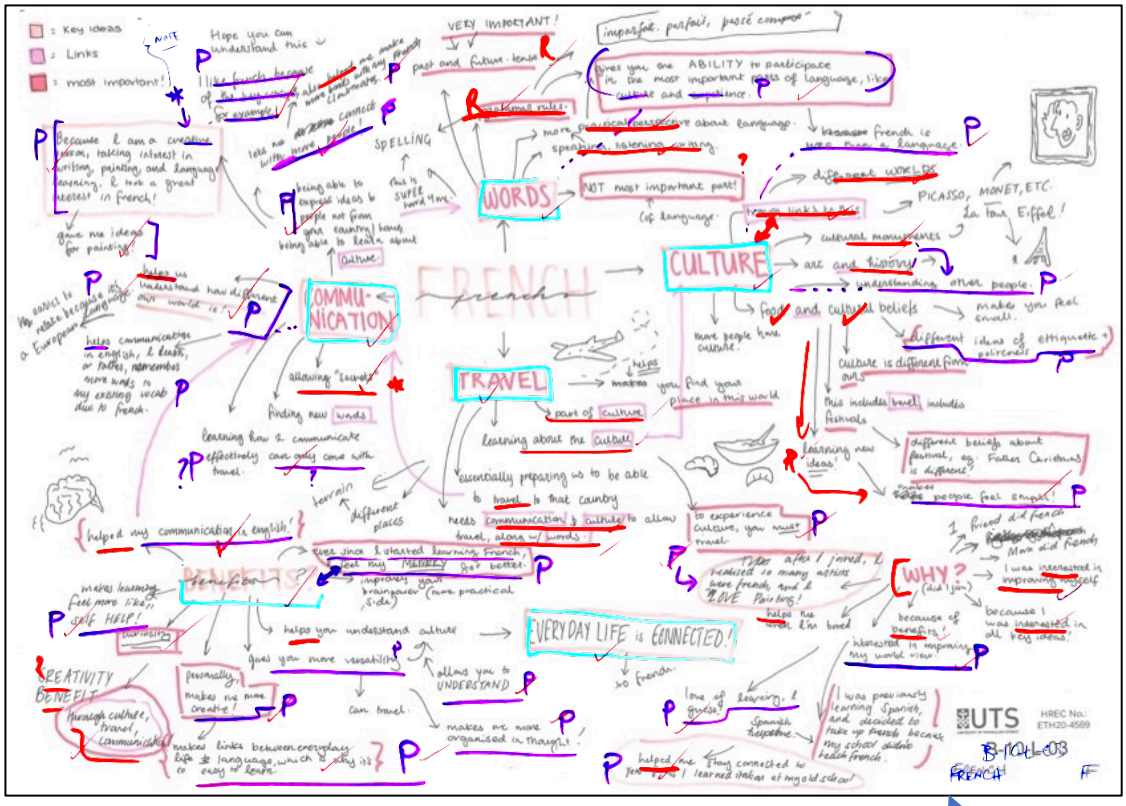


Figure 17 Concept Map overlay method – Steps 1 and 2

Step 3 of the concept map data reduction process is illustrated in Table 7 below, which presents data from the example provided for Steps 1 and 2 in Figure 17 above.

Table 7 Concept map data reduction

Participant	Cat.	Subject	Gen.	Concepts	Relationships	Propositions
B-10-L-03	L	French	F	words	Grammatical rules	Gives one the ability to participate in the most important parts of language
					Tense	
					Practical perspective	
					Speaking, listening, writing	
					Travel links to this	
					Different worlds	French is more than a language
					Cultural monuments	
					Art and history	Understanding other people
					Food	
					Beliefs	
					Learning new ideas	Makes people feel small
				travel	Part of learning about culture	
					Communication and culture	After I joined I realised so many artists were French, and I love painting
					Along with words	To experience culture you must travel
				Everyday life is connected	To French	
					Helps you understand culture	
				benefits	Helped	
					Curiosity	
					Creativity benefit	Personally makes me more creative
						Makes links between everyday life and language which is why it's easy to learn
						Gives you more versatility
						Allows you to understand
						Makes me more organised in thought
				Communication	Allowing secrets	Learn how 2 communicate effectively can only come with travel
						Helps communication in English and learn, or rather remember more words in existing vocab due to French
						Easiest to relate because it's a European language
						Helps us understand how different our world is
						Because I am a creative person, taking an interest in writing, painting and language learning
						I took an interest in French
						Gave me ideas for painting
						I like French because of the key concepts
						Lets me connect with more people
						Being able to express ideas to people not from your country/home
						Being able to learn about culture
						Interest in improving myself
						Interest in key ideas
				Why (did I join)?	Improvement	Interest in improving my world view
					Interest	Love of learning
					Benefits	Helped me stay connect to year 8, as I learned Italian at my old school

In Step 3, relating to Table 7, data from each concept map were tabulated to identify concepts, relationships, and propositions. Each concept map was carefully examined for detail as handwriting on some responses was either small, or difficult to read given the pen or pencil used. Using this technique across the 41 responses was considered reliable as the data produced findings of consistent nature across the three schools (refer Section 3.6.2).

Step 4 of the concept map data reduction process considered reduced and tabulated data from each concept map response to create aggregate data for concepts, relationships, and propositions for each school, and for each Phase. These aggregated data were then arranged into themes identified in the reduced data. Considering the data in terms of themes further reduced the volume of findings into manageable units of meaning that could be used to address the research questions. The process was used consistently across Schools A, B, and C. To illustrate Step 4, School C Phase 1 theme tables are provided in Tables 8, 9, and 10.

Table 8 School C Phase 1 Concepts and Themes

Theme	School C Concepts Identified in the Raw Data Technology students Phase 1	School C Concepts Identified in the Raw Data Languages Students Phase 1	Theme
Reasoning	thinking reality aptitude change	gain perspective	**Reasoning**
		To value Value (nominated as a concept) personal interest (gain life) experience	**Value Perception**
Making / creating	creativity creating interest		
This cell is left intentionally blank.		understand (how we use language) (experience other) cultures spread of culture Influences travel food	**Culture**
		help other people provide opportunities To help impact inspire	**Motivation / Aspiration**
		To communicate To connect (meet and) connect (with people)	**Communication**
		way of learning So, is it just a tunnel? draws influence	**Learning**

Table 9 School C Phase 1 Relationships and Themes

Theme	School C Relationships Technology Students Phase 1	School C Relationships Languages Students Phase 1	Theme
Reasoning	outside the box Make changes (sharing as part of the process) prior knowledge	understand, benefits which helps you to… gain wisdom and understanding diversifies understanding allows for learners to step back and realise their place in the world	**Reasoning**
Making / Creating	my creative background share to make…ideas into reality experience with STEM Hone, broaden their skills	others' future inspire…to help learn a new culture	**Motivational / Aspirational**
		understand native tongue on a new level sense of belonging a worldly subject	**Culture**
		learn new memorisation techniques use a different part of the brain unique thought processes within language a lot of repetition	**Cognition**
		communicate with others that speak the language conversation	**Communication**

Table 10 School C Phase 1 Propositions and Themes

Theme	School C Propositions Technology Students Phase 1	School C Propositions Languages Students Phase 1	Theme
Motivational / Aspirational	Dreams (preferred futures) Inspiration Future Be the future change the world (even if only a little) change someone's life	to value different activities, foods, (animals?) to value different ways people use their language so I can interact with other people in the world without having difficulties understanding to connect different programs, jobs, opportunities helps you understand your own situation and how well-off you are makes connections that monolinguists would not make open up a new world previous success future travel speaking (new language) regularly Enjoyment, learning about other cultures, countries benefit from being even partially bilingual be able to survive and cope in a Francophile country communicate with a more diverse range of people apply skills in learning French to other subjects still always something new constant feeling of progress rewarding but occasionally overwhelming opens up more future options requirement for a scholarship, career	**Value Perception**
This cell is left intentionally blank.	This cell is left intentionally blank.	doesn't mean anything in English, but it does in French can help you accept your own situation can lead you NOT to accept others' hardships as 'just life' understand people's motives, opinions, life experiences learning doesn't happen overnight or from just memorising. It comes from understanding, not rote learning…shared bonds.	**Reasoning**
		to help others to understand different individuals, translate learn through consequences and real-life situations teaching others, helping others my future by giving more people the opportunity to learn and help others around the world I want to help people around the world desire to help others preferred future…living in Europe We aren't everything. We are less important than we think we are = humanity	**Motivational / Aspirational**
		appreciation of new cultures seeing how others live their life is interesting cultural differences are astounding	**Culture**
		appreciation for how communication works understand others and the world better expressing myself in a new language allows me to express myself speaking with locals, asking where places are	**Communication**

3.7.2 Interview data reduction

Follow-up interviews were conducted after concept map creation. In some cases, interviews were conducted in mixed groups of technology and languages participants due to scheduling constraints. The interviews were audio recorded and transcribed. PDF copies of transcripts were used as a basis for reduction and analysis. As a supporting strategy to concept map analysis, a similar approach to 'marking up' was used for transcripts in the use of coloured highlights that reflected concepts, relationships, and propositions. Transparent overlays were not used to markup transcripts. Rather, the transcripts were highlighted directly using a digital PDF reader. The convention is repeated here for reference.

Markups use the following colour coding:

- Concept, highlighted in cyan.
- Relationship, highlighted in red.
- Proposition, highlighted in purple.

The process was repeated consistently for Schools A, B, and C. The complete collection of transcripts can be found in Appendices G, H, and I. To demonstrate the process, examples from School B Phase 1 data are provided below. Figure 18 below presents an excerpt from School B Phase 1 interviews and exhibits how transcripts were marked-up using the above convention.

Participant 2:	00:18	Opportunities?
Participant 3:	00:19	Yeah, I have opportunities as well.
Participant 4:	00:23	Yeah. I have opportunities as well and communication.
Researcher:	00:25	Okay. So opportunity, opportunity, opportunity?
Participant 4:	00:28	Yep.
Researcher:	00:28	Communication and-
Participant 4:	00:28	The links between them.
Researcher:	00:31	Opportunities and-
Participant 4:	00:34	Communication, and just the links between different areas.
Researcher:	00:38	So can you elaborate on that? That sounds really interesting.
Participant 4:	00:42	Different things, different aspects of learning the language, and then how they are connected. There are similarities and differences.
Researcher:	00:48	What do you mean by opportunities? What kind of opportunities are you talking about?
Participant 2:	00:52	Like opportunities for more cultural understanding. So Australia has a lot of problems politically with Indonesia, and if we understood their language a bit easier, then we might be able to understand their culture better. And then we'll have more understanding with them and also opportunities in jobs and to go to university to study Indonesian.

Figure 18 School B Phase 1 Interview Data Reduction

Marked-up data were then tabulated using the same logic as for concept map data. Table 11 below provides an excerpt of School B Phase 1 interview data taken from the transcript above in Figure 18.

Table 11 School B Phase 1 Interview Reduction

School B – Phase 1 Interviews Identified in Raw Data **Concepts**	School B – Phase 1 Interviews Identified in Raw Data **Relationships**	School B – Phase 1 Interviews Identified in Raw Data **Propositions**
Group B01 – Languages students Opportunities Communication Culture Jobs What we're learning. How we're reading it. How we're writing. How we're learning to speak Aspects of culture Intelligence and overall knowledge Think in Indonesian Lost in translation. Values	The links between opportunities and communication. Different aspects of learning the language, and then how they are connected. There's a lot of different ways we're connected through businesses. We're learning new different aspects of culture by learning new words and how to speak. So we know everything, we just have to apply it and we're applying it to different aspects of Indonesian culture. [expands your knowledge] across different subjects and to English speaking skills as well.	Opportunities for more cultural understanding. If we understood their language a bit easier, then we might be able to understand their culture better. We'll have more understanding with them and also opportunities in jobs. If you're really interested in the culture, that will probably inspire you to learn the language. So many more opportunities by understanding and learning Indonesian. Even just putting that you've learned Indonesian on your resume would give you better opportunities for good jobs. A big motivation for me because I would like to talk to them in Indonesian. Learning a new language really improves your memory skills. It just expands your knowledge in a range of different ways and not only in just that one subject. I just generally feel like it expands your mind.

Data from concept maps were aggregated from individual participant responses. Since the interviews were conducted in group format (due to constraints of scheduling), interview data are considered to be recorded 'in aggregate' as shown above. Using the same logic as for concept maps, aggregate interview data were then arranged into themes for analysis. To demonstrate the process of identifying themes in raw interview data, School B Phase 1 interview themes are presented for the excerpt above in the following Tables 12, 13 and 14.

Table 12 School B Phase 1 Interview Theme Table - Concepts

Themes	School B – Phase 1 Interviews Identified in the Raw Data Concepts
Group B01 – Languages students	
Value Perception	Opportunities Jobs Intelligence and overall knowledge.
Learning	What we're learning. How we're reading it. How we're writing. How we're learning to speak
Culture	Communication Culture Aspects of culture. Think in Indonesian. Lost in translation. Values

Table 13 School B Phase 1 Interview Theme Table - Relationships

Themes	School B – Phase 1 **Relationships**
Group B01 – Languages students	
Connection / Linking	The links between opportunities and communication. Different aspects of learning the language, and then how they are connected. There's a lot of different ways we're connected through businesses.
Culture	We're learning new different aspects of culture by learning new words and how to speak. So we know everything, we just have to apply it and we're applying it to different aspects of Indonesian culture.
Learning	[expands your knowledge] across different subjects and to English speaking skills as well.

Table 14 School B Phase 1 Interview Theme Table - Propositions

Themes	School B – Phase 1 Interviews Identified in the Raw Data Propositions
Group B01 – Languages students	
Culture	Opportunities for more cultural understanding. If we understood their language a bit easier, then we might be able to understand their culture better. If you're really interested in the culture, that will probably inspire you to learn the language
Value Perception	We'll have more understanding with them and also opportunities in jobs. So many more opportunities by understanding and learning Indonesian. Even just putting that you've learned Indonesian on your resume would give you better opportunities for good jobs. It just gives you a little more opportunities in that way.
Connection / Linking	So not really knowing the language is almost not like being there to experience what actually happened.
Learning	Learning a new language really improves your memory skills. It just expands your knowledge in a range of different ways and not only in just that one subject. I just generally feel like it expands your mind. I think it just expands, I feel like, your brain's function. It just is constantly thinking in a different kind of way to people who don't know multiple languages. I guess it also shows how much we've progressed in learning Indonesian, and I think I find that fascinating.
Motivation / Aspiration	A big motivation for me because I would like to talk to them in Indonesian.

Theme tables as shown above were created for follow-up interviews at each school. Findings in these tables were considered together with findings in theme tables created from concept map analysis to ascertain whether additional data could be identified. As previously stated, follow-up interview data were collected to provide participants the opportunity to explain responses in a way that could not be done via visual methods. Findings from interview data are examined for each school in Chapter 4 Findings.

3.8 Phase 1 – Phase 2 Focus Question Generation

Phase 1 focus questions were stated as part of the initial research questions. Consistent with stimulus material for concept map generation (Novak, 1995), focus questions were provided to

participants. The focus questions provide a point from which to consider concept map generation. Phase 2 focus questions were generated from analysis of concept maps and interviews produced by participants at Schools A and B. A second version of Phase 2 focus questions was generated from School C after School C Phase 1 data were collected and analysed. Schools A, B, and C were all presented with the same Phase 1 focus questions. This process is described in further detail in the following sections.

3.8.1 Phase 1 propositions

Qualitative content analysis of concept maps is outlined in Section 3.5.2. School A and School B Phase 1 concept maps were examined for propositions, identified as statements observed as groups of words, short phrases or images/sketches that could convey specific meaning (Novak, 1995). In this study, 'proposition' in the noun form is defined as "the act of proposing or a proposal of, something to be considered, accepted, adopted, or done" and "a thing, matter, or person considered as something to be dealt with or encountered" (Macquarie, 2024). Student participants make statements conveying specific meaning about their subjects that are considered, accepted, adopted, done, encountered, or illustrated.

As stated in Section 3.6 Data Verification, it was considered appropriate for the researcher to be the sole interpreter of the data. Propositions were examined for recurring keywords that addressed the research questions and could inform new focus questions for Phase 2. Keywords included single words, or combinations of words such as,

- Logic (how/why)
- Better (improving)
- Skills / techniques
- Making (practical, hands-on)
- Problem (solving)

This method of analysis reflects the position taken by Schreier (2014, para. 2), which allows the "researcher to focus on selected aspects of meaning, namely those aspects that relate to the overall research question". As previously stated, this process also has the effect of reducing the data.

Recurring salient keywords that could influence, add to, or reframe the focus questions used for Phase 2 concept map creation are tabulated below.

Table 15 Salient Keywords identified in School A, B, and C Phase 1 concept maps

School A		School B		School C	
Languages	Technology	Languages	Technology	Languages	Technology
Nil. No languages participants.	Logic Learn Opportunity Skills Future Understanding Better Occupation	Understand Learn Improve Knowing Connection Occupation Problem solving Memory Brain Think	Making Creative Occupation Logic (how/why) Learn Skills / techniques Mind Better (improving)	Learn Understand Speaking Appreciation Future Connect Express Open Enjoy Communicate Ideas	Future Change

It is important to emphasise that the above keywords are reduced from proposition statements ranging from a few words to a complete sentence. This level of data reduction enabled the creation of revised focus questions for the creation of Phase 2 concept maps. Presenting participants with overly complex focus questions based on detailed propositions would have likely had a negative impact on Phase 2 data collection. This is because participants would not have had the time to consider that level of depth in the time allocated. Examples of such sentences from the data include,

Languages

To know you and your surroundings

Appreciation for how communication works

It comes from understanding, not rote learning

Learn through consequences and real-life situations

Technology

I thought this subject would be mainly design and the design process, but it is mostly research assignments.

I value a logical answer

I rather enjoy building things, hand-working and metalworking

Government suppression of innovation

However, this does not exclude full proposition statements from the complete analysis. Full proposition statements such as the examples listed above are considered in Chapter 4 Findings.

3.8.2 Phase 2 focus questions

Phase 1 focus questions were centred around the objectives of the research questions. They were presented to participants as shown in Box 1 below.

Phase 1

How do you conceptualise STEM / Technology Education / Languages?

What factors influenced your sense of value in making this subject selection?

Box 1 Phase 1 Focus Questions - Schools A, B, and C

After consideration of keywords listed in Table 15 above, the focus questions for Phase 1 were revised and a unique set of questions was issued to technology and languages students for Phase 2. The Phase 2 questions for schools A and B did not include Phase 1 keywords from school C. This is because school C was only introduced after Phase 1 and 2 data collection had occurred for both schools A and B. Phase 2 focus questions for Schools A and B, technology and languages students are present in Box 2 and Box 3 below.

Phase 2 – for technology students, schools A & B

When asked to conceptualise their subjects, students from **languages** classes generated 'meaningful statements' that included…

- To better, or truly understand…to gain understanding…understanding other people…deepening understanding
- To learn…benefits your learning abilities…easy, fun to learn
- Improves memory skills…intelligence across subjects
- Beneficial to the brain…both sides of the brain
- Connection…lets me connect

If you were to consider those as propositions **to you** for your subject, how might you re-conceptualise your subject?

What else might you consider?

Box 2 Phase 2 focus questions, technology students Schools A and B

Phase 2 – for languages students, schools A & B

When asked to conceptualise their subjects, students from **technology** classes generated 'meaningful statements' that included…

- To make, build… with skills and techniques…learn (new) skills
- To design…solve (problems)
- To create…be creative
- Ask why, how… use logic
- To improve…make better

If you were to consider those as propositions **to you** for your subject, how might you re-conceptualise your subject?
What else might you consider?

Box 3 Phase 2 focus questions, languages students, Schools A and B

School C was added to the study after Phase 1 and 2 data had been collected for Schools A and B. This was because it was not considered that data saturation had been reached. For consistency, School C Phase 1 data were also analysed using the same method as for Schools A and B, to examine for additional 'meaningful statements' arising from participants. Additional statements that influenced the development of Phase 2 focus questions presented to School C were derived from Table 15 above and included,

Technology participants
The future...be the future
Change...change the world...change someone's life

Languages participants
To help...help others
Speaking...expressing myself...helping others understand (translate)
Appreciation, to appreciate...to appreciate one's situation.

Phase 2 focus questions presented to School C included the above additions. They are shown in Box 4 and Box 5 below.

Phase 2 Focus Questions – School C

When asked to conceptualise their subjects, students from **technology** classes generated 'meaningful statements' that included…

- To make, build… with skills and techniques…learn (new) skills
- To design…solve (problems)
- To create…be creative
- Ask why, how… use logic
- To improve…make better
- The future…be the future
- Change…change the world…change someone's life

If you were to consider those as propositions **to you** for your subject, how might you re-conceptualise your subject?

What else might you consider?

Box 4 Phase 2 Focus Questions, Technology Students, School C

Phase 2 Focus Questions – School C

When asked to conceptualise their subjects, students from **languages** classes generated 'meaningful statements' that included…

- To better, or truly understand…to gain understanding…understanding other people…deepening understanding
- To learn…benefits your learning abilities…easy, fun to learn
- Improves memory skills…intelligence across subjects
- Beneficial to the brain…both sides of the brain
- Connection…lets me connect
- To help…help others
- Speaking…expressing myself…helping others understand (translate)
- Appreciation, to appreciate…to appreciate one's situation

If you were to consider those as propositions **to you** for your subject, how might you re-conceptualise your subject?

What else might you consider?

Box 5 Phase 2 Focus Questions, Languages Students, School C

3.9 Summary: Methodology to Findings

This qualitative study collected data from forty-one participants across three coeducational independent, K-12 Christian schools. Two were in New South Wales (NSW). A third was in the Australian Capital Territory (ACT). Participants included technology students and languages students, and one technology teacher. The concept maps and interviews investigate student conceptualisations of the subjects that participants were studying, and which the teacher was teaching, independently of curriculum or assessment. Data were collected as physically drawn concept maps and follow-up interviews conducted after the concept map creation. Data were collected in two Phases to ascertain whether conceptualisations from technology students could influence conceptualisations from languages students and vice versa. Data were analysed using qualitative content analysis of concept maps using the framework of concepts, relationships, and propositions as outlined by Novak (1995). The same framework was applied to the analysis of the supporting strategy of follow-up interviews. Data were considered in aggregate to identify themes which had the effect of reducing the data to address the research questions.

The research instrument was considered for validity, reliability, generalisability, and objectivity. Representative samples of concept maps were discussed in Section 3.6. The samples were shown to have produced results that addressed the focus questions provided to participants in a manner consistent with concept map creation. Participants were permitted the freedom to depart from a strict concept map structure if that better enabled them to respond to focus questions. Samples indicate that variation in concept map creation did occur, however that such variation did not detract from the accuracy of the responses. The data collection instrument produced responses consistently across the three research sites and was therefore considered reliable. The study was not considered to produce generalisable findings, rather that findings were unique to each context in a manner similar to the study by (Holmlund et al., 2018). Teachers using this method within their own contexts would interpret findings in the same manner as the researcher interpreted findings in this study. Therefore, interrater analysis was not considered necessary for this study. Objectivity was maintained throughout the study in that the researcher facilitated data collection and provided instruction to participants yet did not participate or assist in the production of data. However, the researcher is not entirely independent from the context of the study and acknowledges the presence of the “researcher’s self” (Denscombe, 2007, p. 298). This presence is declared in Chapter 3.6.4 and is explored further in the Chapter 4.1 Foreword.

Data reduction produced theme tables which are outlined in Chapter 3.7. Data were reduced from Phase 1 and Phase 2 in response to focus questions outlined in Chapter 3.8.

To assist the reader in following the process of data collection for analysis and prepare for documentation of findings, the process of data collection, analysis, and reduction is illustrated in Figure 19.



Figure 19 Summary: Methodology to Findings

Chapter 4.0 Research Findings addresses the research questions. It is preceded by a foreword stating the 'researcher's mission' and declaring the researcher's self. It is supported in Chapter

4.1.1 with guidance on navigating Chapter 4.0 Findings. Chapter 4.1.2 provides guidance in the identification of themes.

Chapter 4: Research Findings

4.1 Foreword – The Researcher's Mission

As might be prefaced before a feature film or novel, 'this study is based on actual events'. That is, the researcher was a character in the wider story being investigated. However, only after 20 years' experience as a teacher did a moment occur for the researcher that converged the two seemingly disparate disciplines of technology and languages. This convergence would produce a question that could address the current conundrum. Technology, though highly popular in the global Zeitgeist, remains underrepresented in the popularity of subjects being taught in Australian secondary schools. Staffing and resourcing technology subjects also remains problematic. The study of foreign languages in schools is also sub optimal with low student numbers and shortages with staffing. Yet, students continue to choose these subjects despite the difficulties in keeping them alive and resourced. There is clearly a value proposition to some, albeit strained. The convergent moment occurred when the researcher, a technology teacher of over two decades' experience, was faced with students in a technology class who were also studying languages. Intensifying the convergent moment was that the researcher was also teaching languages out of area at the time, to the same students, as a first-time out of area teacher. The language was German. Whilst not uncommon for teachers to teach out of area, the situation was fortuitous given the researcher's German background and native knowledge of the language. From the perspective of the researcher, it seemed like a natural fit. To others, notably the students, it was most unusual.

Much reflection by the researcher revolved around the notion that such a combination seemed very normal to the researcher. Moreover, that a clear case could be made for studying or teaching such a combination of subjects. And that making such a combination known or available to students would provide synergistic benefits that would help stem the tide of decline and provide a pathway for growth. However, this is only wild speculation from a single biased viewpoint. To determine any possible feasibility, it would be necessary to develop appropriate research questions and allow the students to inform the answer. It was also at this point that the researcher realised that whilst participating in teaching technology subjects, personal attempts to grow interest and student numbers had produced some results in the researcher's immediate context, though little in the wider context. Something else was needed. It would become a mission.

Since the concept seemed so clear to the researcher, the initial formation of the over-arching research question also centred around conceptualisation. Students enrol in subjects and are taught curriculum content. From the researcher's experience and reflection, it became apparent that students may indeed *not* have a 'concept' in their minds of what the subjects are that they

choose. That is, there is no working construct or framework upon which they can build knowledge. And if no such foundation exists, then value gained from the subject is based potentially only from the experiences provided, and not from the student's aspiration or ambition to learn. Students thought they would do 'X' but ended up experiencing 'Y'. Hopes of a value proposition dashed.

Therefore, the over-arching research question was deemed appropriate to ask:

> **RQ1** How do students conceptualise the technology and languages subjects they study, independently from notions of assessment or curriculum?

However, the idea that students aspire to, or are ambitious to learn is also an assumption that is subject to varying levels of teacher expectation. Teachers who are highly engaged in and motivated by their subject content may be surprised to find that students could have very different ideas about how they get value from the subject. Or, if they get value out of the subject at all. As a character in this story, the researcher was also prone to this assumption. This leads to what Christensen et al. (2004) describe as asymmetry of motivation, or a mismatch in expectations. To ensure value perceptions and motivation to learn are aligned between teachers and students, it would be necessary for teachers to understand how students construct notions of value about the subjects they undertake. This is not to suggest that student value perception alone should dictate curriculum content or learning outcomes. However, it is likely that a better understanding of how students perceive value in their subjects may help teachers address curriculum content more effectively.

Therefore, a second research question underlying the primary research question of conceptualisation asks the following:

> **RQ2** To what extent did value propositions offered by those subjects, and resulting from the conceptualisation strategy, motivate students to study those subjects?

As stated, languages and technology subjects face a conundrum of low student numbers and high challenges to facilitate them. Yet the students continue to enrol in them, and schools continue to struggle. If students can indeed conceptualise their subjects and communicate where they feel the value proposition lies, then a question arises of what can be learned from this perplexing situation. A perspective could be taken that rather than simply trying to manage the conundrum, one could understand it and leverage the findings. Languages and technology are disparate learning areas, although their students share a motivation that continues to draw them in at the fringe of the curriculum. Understanding why these students share these motivations could inform how students are introduced to languages and technology to grow enrolments. Moreover, understanding the motivation and commitment to the subjects could also inform how students are guided towards making better informed subject selections generally.

Rather than simply choosing from a list of available subjects that suit a given schedule, students could be taught to recognise future value as a motivator in decision making.

Therefore, a third research question underlying the above two research questions was developed to ask:

> **RQ3** To what extent are there complimentary value propositions between technology and languages subjects, and how do students express this?

With the above three questions the mission is set. Engage with students allowing them freedom in their responses within a given data collection method, and then let the data speak. A commonly lauded attribute for students to acquire is the ability to engage in creative and critical thinking. The researcher is aware that giving students the opportunity to answer these three questions freely and without 'assessment' could trigger much critical response which may be confronting, and challenge assumptions long held by the researcher. However, to truly understand the conundrum and effect change, this investigation is a mission that must be accepted. With that acceptance, it is the findings within the data to which this chapter now turns.

4.1.1 Findings navigation

To assist the reader of these findings, the following navigation advice is provided. The findings are divided into three sub-sections within this chapter to address each research question independently.

> **Chapter Section 4.2:** Conceptualisation – Research Question 1
> **Chapter Section 4.3:** Proposition and Value Perception – Research Question 2
> **Chapter Section 4.4:** Relationships and Complementary Value – Research Question 3

Allocating the research findings to sub-sections as shown above enables the reader to focus on each research question independently within a large overall volume of data.

The study employed a Phase 1 / Phase 2 structure across three schools creating multiple groups of findings for consideration. Each of the following Sections, 4.2, 4.3, and 4.4 follow the same procedure of analysis to ensure consistency across the data sets. The procedure is illustrated diagrammatically in Figure 20 below.

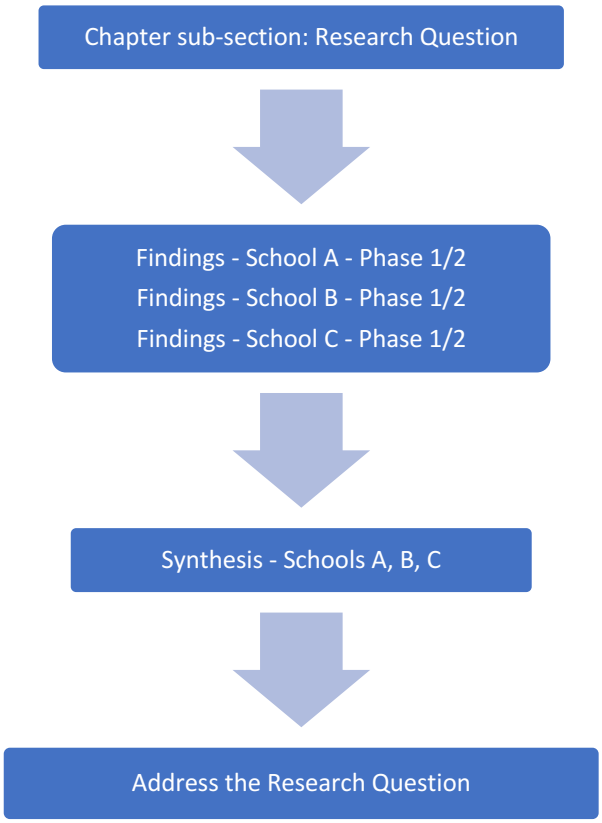


Figure 20 Findings Navigation

4.1.2 Findings identification of themes

Data reported on in this findings chapter were reduced into themes identified in concept maps and follow-up interviews as outlined in Chapter 3 Methodology. In addition to the effect of reducing the data, themes provide a basis upon which to discuss the data in a manner that specifically addresses the research questions.

This section of the findings chapter provides guidance on the approach used to identify themes in concept map data. The guidance prepares the reader to understand the documentation of findings more easily. It makes clear that findings were not the product of a 'thematic analysis' of the entire data set. Rather, that themes identified from concepts, relationships, and propositions in concept map data allowed for better examination of the research questions. The analysis did not take a mixed methods approach of 'concept map analysis' and 'thematic analysis'. Themes are not a typical output of concept map analysis; however, participants were not being assessed on the knowledge of their subjects. Rather, personal participant conceptualisation of their subjects was investigated. The themes identified were used as a supporting strategy in the analysis because themes enabled the researcher to focus on conceptualisation rather than correctness as represented by the concept map. As stated, concept maps are typically used to assess knowledge however wider application is acknowledged (Novak, 1995). In this study, the

wider application of concept maps enabled the investigation of conceptualisation and value perception for which themes provide helpful guidance.

Gibson and Brown (2009, p. 3) note that “thematic work, in some form or other, is a very common aspect of qualitative theory”, but that approaches to identifying or coding themes vary. They cite Henn et al. (2007) who state that “coding is a process for which there are no rules, merely guidelines” in Gibson and Brown (2009, p. 3). Such guidelines may be determined by established approaches such as ‘cross-case’ analysis (Orosz et al., 1997), ‘narrative analysis’ (Mishler, 1990) or ‘genre analysis’ (Gibson & Brown, 2009). Thematic analysis as described by Braun and Clarke (2006) in the field of psychological research is also referenced in this thesis in studies involving interview analysis (see Chapter 3.5.4).

In this study, the identification of themes aligns with the process broadly outlined by Gibson and Brown (2009) due to its resonance with the identification of concepts as described by (Novak, 1995). Gibson and Brown (2009, p. 2) refer to the term ‘thematic analysis’ as “the process of analysing data according to commonalities, relationships, and differences across a data set. The word ‘thematic’ relates to the aim of searching for aggregated themes within the data”. Similarly, in the context of concept maps used in this study, the identification of concepts as described by Novak and Cañas (2008, p. 1) is defined by “the perceived regularity in events or objects, or records of events, or objects, designated by a label”. Cross-links or interrelationships on the concept map reinforce the relationships between the identified labels, establishing connection and hierarchy in the participant’s conceptualisation in response to the stimulus focus question. Since the responses from concept maps were analysed in aggregate and not for each individual participant, the use of themes is considered appropriate for addressing the research questions.

Themes are discussed in relation to the research questions in the following chapter sections. To identify themes identified in the data, reduced concepts, relationships, and propositions are presented as ‘components’ of the theme. Samples of this process are provided in Tables 16, 17, and 18 which indicate themes and the components that defined those themes. The samples are representative to illustrate the process and to avoid unnecessary duplication of theme tables in this findings chapter.

Table 16 Theme Identification Sample - Concepts

School A – Concepts and Themes Identified in the Raw Data Technology Students		
Theme	**Concepts**	
	Phase 1	**Phase 2**
Vocation / technology discipline	job/employment future career Elon Musk Tesla innovation careers military hardware	Non-traditional engineering jobs
Learning	Thought process. Teacher to class learning. learning new skills reality (of class experience) practical skill development	brain memory connection propositions understanding learn skills

In Table 16, the theme ‘vocation / technology discipline’ is identified by the components shown for School A Phase 1 and Phase 2 responses recorded as concepts on concept maps. The concepts indicate a commonality across the notion of work or employment, represented by direct use of the word ‘job/employment’ or by implication through company brand names such as ‘Tesla’ (automotive and energy business) or people who represent those brand names (Elon Musk). These concepts (components of the theme) imply both a type of work (technological) or discipline within a technology space such as the military or automotive design. ‘Military hardware’ is included in this theme due to the broad technologies associated with making such hardware, and the career opportunities available in the military. ‘Innovation’, whilst not a technology discipline or job, can be tied with a successful career, enterprise, or technological pursuit.

Learning is identified as a theme due to the direct use of the word ‘learn/learning’ and references to teachers, class, and the learning of new skills. The reference to cognitive function (memory) and the brain, understanding, and skills support the identification of ‘learning’ as a theme. ‘Propositions’ and ‘connection’ are included as they imply a process in which the student is learning through the concept mapping process.

Table 17 Theme Identification Sample - Relationships

Theme	School B Relationships Technology Students Phase 1	School B Relationships Languages Students Phase 1	Theme
Reasoning	convergent divergent lateral analogy finding a solution / reasoning trying new things / failure is OK finding solving reframing how does it help? what is the purpose? creative critical real life & theoretical issues integrating	language on resume occupation able to communicate differently enjoyable learning environment travelling opportunities get better grades enabling myself to become familiar assists in, travel, career options travel career options helps connect makes travelling more fun love influence beneficial learn familiarity beautiful language occupational choices Australia's closest neighbour can do it at uni more respect and kindness Aus becomes closer to Indonesia fun / favourite	**Value Perception**

In Table 17 the theme of ‘reasoning’ is identified. Reasoning in this study assumes the definition of “the process of drawing conclusions or inferences from facts or premises” (Macquarie, 2024). Seen here in the context of relationships, the theme of reasoning was identified in the findings where participant responses indicated an attempt to draw concepts together to form a line of thinking or perception. The reasoning process creates relationships between concepts to form propositions. In this way, the concepts represent the facts or premises, which are then drawn together to form propositions as a result of the relationships created by participants. Reasoning was considered to act as a bridge or connection between the conceptualisation and propositions held by the participants. The manner in which reasoning appeared in the data is discussed in further detail in Sections 4.3 and 4.4 of this chapter.

The theme of ‘value perception’ as shown in Table 17 is an example of how some themes are represented by a larger volume of components in some responses. The effect of data reduction through the creation of themes becomes visible in this example. The resultant groupings may also include some overlap of components between themes, and this is expected given the volume and variation in responses. The overlap is still considered to be within the boundary of data validity since the researcher was required to draw a distinction at a point reasonable for the purpose of addressing the research question.

How a person perceives value is subjective. Participants may hold opposing perceptions of value which required the researcher to consider each component of concepts, relationships, and propositions from more than one perspective. Perceptions of value in Table 17 were identified where there was an obvious description of value including responses such as ‘enjoyable learning environment’, ‘get better grades’, ‘helps connect’, ‘beneficial’, ‘fun/favourite’. Other responses in this example were also considered to represent value perception and were grouped that way as part of the data reduction process. Without the use of themes, it would be impractical to list each component for its individual value perception due to the volume of data collected.

Table 18 Theme Identification Sample - Propositions

Theme	School C Propositions Identified in the Raw Data Technology Students Phase 1	School C Propositions Identified in the Raw Data Languages Students Phase 1	Theme
Motivation / Aspiration	Dreams (preferred futures) Inspiration Future Be the future. Change the world (even if only a little) Change someone's life	To help others to understand different individuals, translate. Learn through consequences and real-life situations. Teaching others, helping others my future. By giving more people the opportunity to learn and help others around the world. I want to help people around the world. Desire to help others. Preferred future…living in Europe. We aren't everything. We are less important than we think we are = humanity.	**Motivation / Aspiration**

In Table 18, a sample for the theme of ‘motivation/aspiration’ is compared for School C technology and languages participants. Table 18 illustrates another example of how theme identification reduces the volume of data to a more usable scale. Propositions in this example (theme components) such as ‘change the world’, ‘change someone’s life’, and ‘inspiration’ may be considered as valuable for the participant and therefore appropriately themed as ‘value perception’. However, ‘motivation / aspiration’ was identified as the theme due to the other-person centred nature of the responses. An assumption is made here that ‘change’ and ‘inspiration’ are for the better. More explicit communication of benefit to other people is found in propositions including,

- to help others
- teaching others, helping others
- by giving more people the opportunity to learn and help others around the world
- I want to help people around the world
- Desire to help others

- We are less important than we think we are = humanity.

An alternative for this theme could have been labelled ‘altruism’. However, there is an indication in the responses that participants are driven to these proposition conclusions with words such as ‘to help’, ‘by giving’, ‘I want to help’, ‘desire to help’. The researcher concluded that the desire for other person centredness was intrinsically motivated, and that to reach this state or level of ability as a result of their studies was something that participants aspired to. It is acknowledged that the rationale for identifying motivation and aspiration in these responses is subjective. However, it would be subjective for any reader of these propositions. As the rationale was applied equally and impartially across all data in the study, the identification of ‘motivation/aspiration’ is considered to be reliable in the data as it could be used to address the research questions.

Tables 16, 17, and 18 are representative samples of how themes were identified in the data. Themes are comprised of components made up of concepts, relationships, and propositions. Themes identified in aggregate across the three Schools are listed in Table 19. A definition, or rationale for identification for each theme is provided in Table 20 which assists in comprehending how the data address the research questions.

Table 19 Themes Identified - Schools A, B, C

	School A	School B	School C
Concepts	Vocation / technology discipline Learning School subject Value perception	School subject Creating / making Value perception Reasoning Vocation / technology discipline Motivation / Aspiration Learning	Reasoning Making / creating Value perception Culture Motivation / aspiration Communication Learning Insight
Relationships	Motivation / aspiration Vocation / technology discipline Learning Military	Reasoning Motivation / aspiration Making / creating Value perception Vocation / technology discipline Military Culture Learning Frustration	Reasoning Making / creating Motivation / aspiration Culture Cognition Communication
Propositions	Value perception Reasoning Learning Economic development Vocation / technology discipline	Motivation / aspiration Efficiency / improvement Function / utility Value perception Making / creating Frustration Choice Learning International relations Understanding Passion Insight Language Connection	Motivation / aspiration Value perception Reasoning Culture Communication

Themes in Table 19 are shown in the order in which they appeared in the data.

Themes in Table 20 are listed alphabetically for ease of reference.

Table 20 Definition / Rationale for Identification of Themes

Theme	Definition / Rationale for Identification
Choice	Responses indicating reasons for a course of action including language such as 'why I chose', 'interest in key ideas', 'I would not choose', 'I wish this subject could be'.
Cognition	References to 'brain', 'understanding', 'thinking', or cognitive functions (e.g., memory)
Communication	Responses indicating interaction and/or conveying information to another person or culture. The ability to speak or express thoughts and words to another person.
Connection	Language including 'encountering', 'making connection', 'others'.
Culture	Use of the word 'culture', 'cultures', 'cultural', or groups of words such as 'food, culture, language'. References to 'community' and 'identity'. Cultural icons such as 'temples' and 'artworks'. Experiences of culture, or 'experience other culture', 'appreciation of culture', 'cultural differences'.
Economic Development	References to 'the economy', opportunities for industry such as 'Australian miners', 'leaders', 'government'.
Efficiency / Improvement	References to improved methods such as 'better, efficient ways of doing things', 'automation', 'designing for people'.
Function / Utility	Responses indicating delivery of a solution, or client expectation. A job completed.
Frustration	An indication of limitation, restriction, disappointment, or regret.
Insight	References to 'wisdom', 'using logic', 'similarities with new skills-logic-improve'
International Relations	References to 'political', 'international relations', relationships between countries.
Language	References including 'mother tongue', 'learning', 'understanding', 'knowing' language.
Learning	Use of the word 'learn', 'learning', 'class', 'teacher', or 'class' experiences. References to cognitive function such as 'memory', 'thinking', 'brain', 'understanding'.
Making / Creating	References to making objects, designing, practical classroom, or workshop experiences, skills. Developing of a product, system, or environment.
Military	References to military in general, or military divisions such as 'army', 'navy', 'air force'.
Motivation / Aspiration	A response suggesting other person centredness. Intrinsic motivation characterised by language including 'to help', 'by giving', 'I want to help', 'desire to help'.
Passion	Inspiration and/or emotion; language including 'close to my heart', 'shapes', 'love', 'ideas', 'love of learning'.
Reasoning	Responses indicating an attempt to draw concepts together to form a line of thinking or perception. "The process of drawing conclusions or inferences from facts or premises" (Macquarie, 2024).
School Subject	Titles of subjects undertaken at school, such as 'maths', 'mathematics', 'science'. Specific languages such as 'French', 'Indo', 'Indonesian'.
Understanding	Use of language including 'understanding culture', 'understand the language', 'knowing (you and your surroundings)', 'deepening understanding', cognition.
Value perception	Words, groups of words, short phrases or sentences conveying a sense of value, benefit, gain, or utilitarian value. May pertain to an experience, credential, skill, opportunity, or emotional response (e.g., enjoyment).
Vocation / Technology Discipline	Explicit use of job titles, job types, or areas of work. A broadly definable technology discipline.
School Subject	Titles of subjects undertaken at school, such as 'maths', 'mathematics', 'science'. Specific languages such as 'French', 'Indo', 'Indonesian'.
Understanding	Use of language including 'understanding culture', 'understand the language', 'knowing (you and your surroundings)', 'deepening understanding', cognition.
Value perception	Words, groups of words, short phrases or sentences conveying a sense of value, benefit, gain, or utilitarian value. May pertain to an experience, credential, skill, opportunity, or emotional response (e.g., enjoyment).
Vocation / Technology Discipline	Explicit use of job titles, job types, or areas of work. A broadly definable technology discipline.

The definitions / rationale in Table 20 were applied impartially and consistently across all data. They are discussed with respect to the research questions in the following sections.

4.2 Conceptualisation – Research Question 1

Research Question 1 How do students conceptualise the technology / STEM / languages subjects they study, independently from notions of assessment or curriculum?

Data reduction described in Chapter 3 followed the process of identifying perceived regularity of objects that represented concepts and records in concept maps (Novak, 1995). No scoring process was used to assess the concept maps for correctness as the research question addressed student conceptualisation rather than curriculum knowledge or understanding. In accordance with qualitative content analysis described in Chapter 3, keywords and themes were identified in the raw data in response to the researcher's prompt for students to produce concept maps. Keywords and themes were further reduced to produce tables of themes, and the components of those themes for both Phase 1 and Phase 2 of the study. Follow-up interview data reduction also identified themes to produce similar tables for Phase 1 and Phase 2 of the study. To address the research question, the concepts and themes identified in each school, via concept maps and follow-up interviews, are presented sequentially in Sections 4.2.1, 4.2.2, 4.2.3. The themes are then considered collectively to arrive at consolidated findings to address the research question in Sections 4.2.4 and 4.2.5. To support the findings discussed, selected tables from the reduced data are included in this chapter.

4.2.1 School A – concepts and themes

Concepts and themes identified in School A concept maps are shown in Table 21 below.

Concept Maps

Table 21 School A - Concepts and Themes

School A – Concepts and Themes Identified in the Raw Data Technology Students		
Theme	**Concepts**	
	Phase 1	**Phase 2**
Vocation / technology discipline	job/employment future career Elon Musk Tesla innovation careers military hardware	Non-traditional engineering jobs
Learning	Thought process. Teacher to class learning. learning new skills reality (of class experience) practical skill development	brain memory connection propositions understanding learn skills
School Subject	iSTEM science electronics programming 3D printing/design/structures computing time	iSTEM
Value Perception	what I value solving big issues	

School A Phase 1 concept maps identified twenty-three concepts. Concepts are mostly listed as single words. In some cases, more than one word is recorded as a concept. Reasons for this include,

- The presence of similes, such as ‘job/employment’.
- Related constructs presented as one expression on the concept map, such as ‘3D printing/design/structures’, and ‘solving big issues’, and ‘reality (of class experience)’.
- Concepts simply requiring more than one word, such as ‘military hardware’, ‘subject at school’.

Participants at School A were all iSTEM students. There were no year 9 or 10 students at the school studying languages. The concepts presented reflect STEM related language, although not exclusively. One concept is identified as noteworthy: The concept of “non-traditional engineering jobs”. Whilst occurring only once, it is noteworthy for consideration in later discussion.

Morphologically, the concept maps were consistent across the cohort of participants with only minor variations in structure. Broadly, participants produced concept maps that showed concepts as larger, more dominant words, which were then connected with drawn lines to

smaller, subordinate words to show relationships between the larger concepts. Figure 21 demonstrates a typical example of this structure in this cohort.

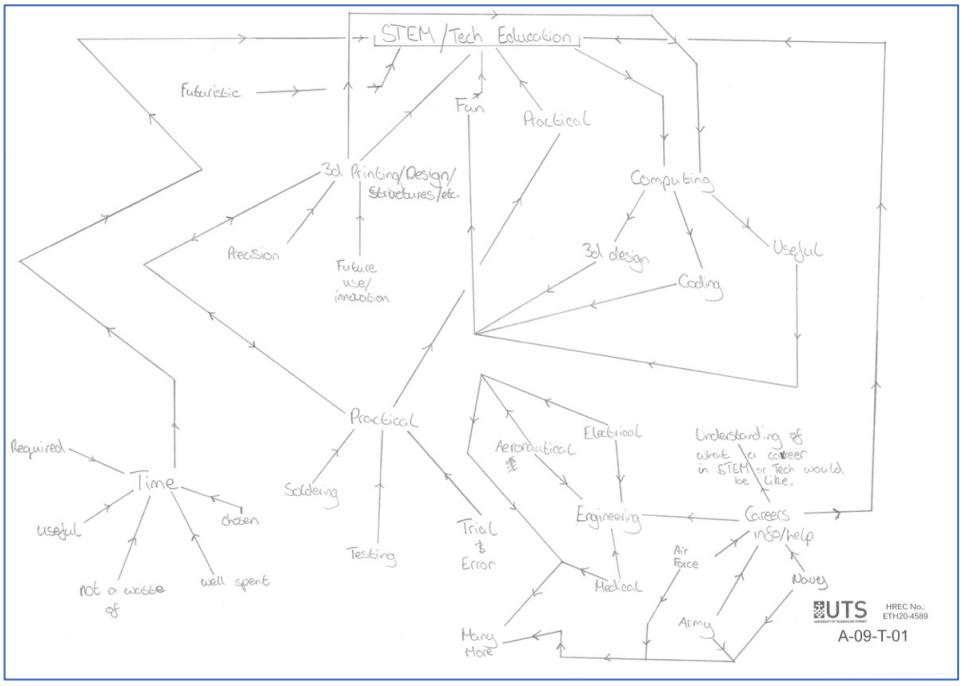


Figure 21

In one case there was a direct departure from the typical concept map structure, shown in Figure 22 below. The participant drew a smaller diagram which was then supported by handwritten words and sentences as the dominant form of response.

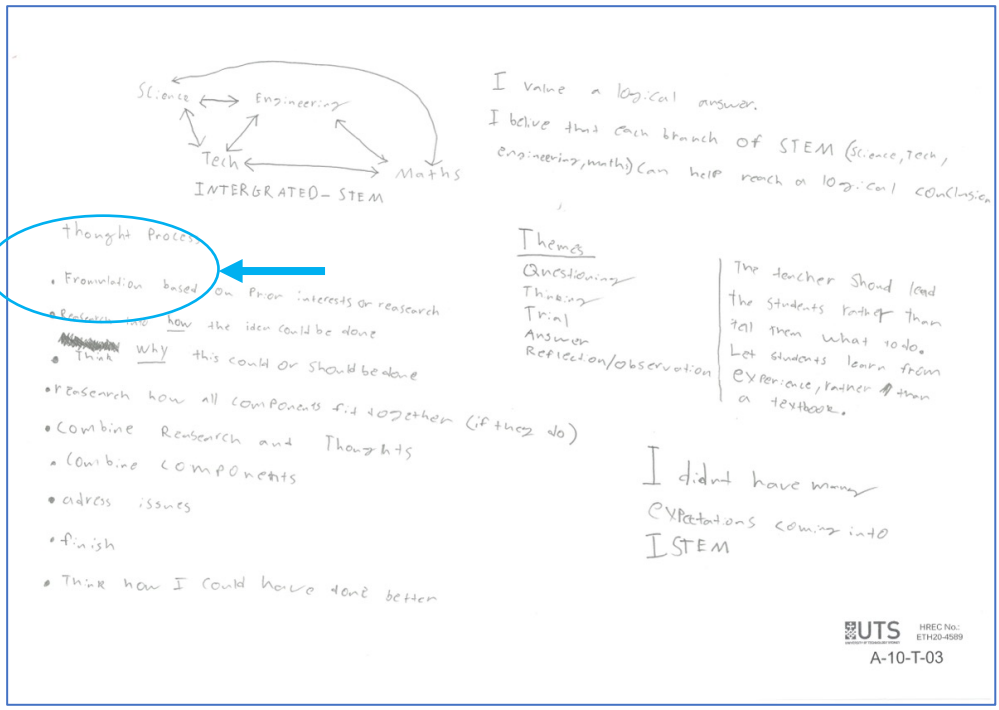


Figure 22

Whilst not a typical concept map structure, participants were allowed the freedom to represent the concept maps in whatever manner they considered most effective to provide an authentic response. The concept map in Figure 22 is noteworthy for this reason because close inspection revealed only one over-arching concept which then produced in-depth propositions. As indicated on Figure 22 by the blue arrow and ellipse, the concept of “thought process” was supported by the sentences around it. In this case, the participant spent more time exploring propositions in sentences and words after identifying the main concept.

Usage of imagery was limited to two Phase 1 responses. Whilst only occurring twice, the notions depicted are considered important because they indicate a recognition of brand names, people and logos. In Figure 23 below, the respondent makes clear reference to a person (Elon Musk) and the brand name (and logo) associated with that person (Tesla) as key concepts within the map. At this point a direct link to an outcome of STEM learning is made which is beyond the school or subject context: a possible indication of an emerging value proposition.

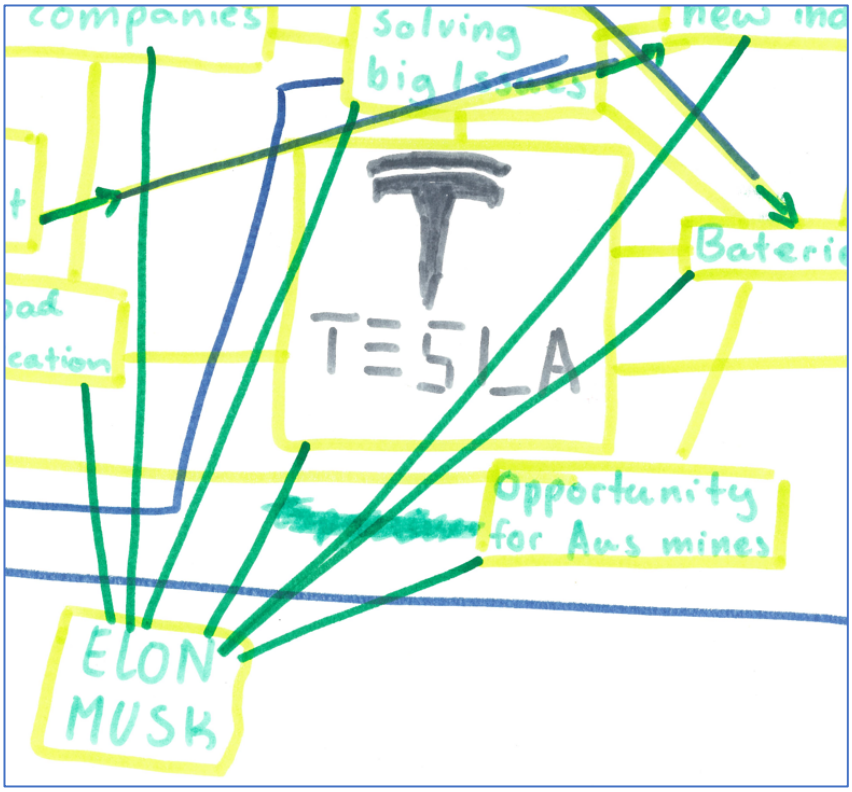


Figure 23

Phase 2 concepts from concept maps are reduced in number to fourteen (or twelve when adjusted for duplicates). Participants produced roughly half the number of concepts in Phase 2, however there are notable additions to the overall concepts produced. Additional Phase 2 concepts which stand out from Phase 1 concepts include,

- Brain

- Memory
- Connection
- Propositions
- Understanding
- History

Linkages exist between these new concepts listed for School A Phase 2 participants, and the concepts listed for School B Phase 1 languages participants. Table 22 below indicates examples of where the connections begin to emerge.

Table 22 School A & B Phase 1&2 Concepts

School A Phase 2 Concepts **Identified in the Raw Data** **Technology students**	**School B Phase 1 Concepts** **Identified in the Raw Data** **Languages students**
brain / memory	Changes the way your brain works. Learning with a different part of the brain Learning / knowledge
connection	Everyday life is connected
propositions	Opens up opportunities and branches. Ability to communicate with foreigners. Learning about others.
understanding	Understanding the world. Understanding differences.
history	History Culture, Empires

Note that concepts from School B Phase 1 languages participants are generally more than one word, and in some cases are short phrases or sentences. Themes arising from concept map analysis were broadly arranged into,

- Vocation / technology discipline
- Learning
- School subject
- Value perception

(Refer Table 21)

The concepts contained within the themes of ‘vocation / technology discipline’ and ‘subject at school’ were easily identifiable as specific words or references such as ‘iSTEM, science, electronics, programming’ and ‘career, TESLA, military hardware’. These are themes and concepts that could be considered broadly in line with expectations. Noteworthy to the researcher was the early inclusion of themes related to ‘learning’ and ‘value perception’. Students were asked to consider factors that contributed to their sense of value in undertaking the subject, and therefore some reference to ‘value’ was expected. Clearly present in the data

was a high-level conceptualisation of ‘learning’. That is, students appeared to have a concept of what learning should be like and that this should match their classroom experience. Concepts (components of the theme) within the theme of learning such as,

- thought process
- teacher to class learning
- practical, and
- skill development

indicate that students see themselves in the process of building knowledge and skills through active participation and teacher interaction. Learning is an action that produces capabilities rather than learning as passive information gathering and storage. Moreover, that students have a concept of the subject which involves learning, rather than mere exposure to subject content.

One concept in School A Phase 2 responses is identified as particularly noteworthy: The concept of “non-traditional engineering jobs”. As previously stated in Chapter 3, data may only appear once, however this does not necessarily reduce the significance (Drisko & Maschi, 2015). From the perspective of content analysis, the theme of ‘vocation / technology discipline’ was identified in both Phase 1 and Phase 2 responses for School A. Phase 1 produced a list of concepts which are easily associated with that theme and could even be described as utilitarian in nature. However, in Phase 2, ‘non-traditional engineering jobs’ is the only vocation / technology discipline concept emerging relating to that theme. Referring again to Table 21 above, more attention was given to concepts relating to the theme of ‘learning’. A shift in focus or awareness is apparent. The concept of ‘non-traditional engineering jobs’ is not expanded upon in the concept map, however, is considered again in the follow-up interviews.

Follow-up Interviews

Concepts and themes identified in follow-up interviews for School A, Phases 1 and 2 are shown in Table 23 below (see also Appendix I).

Table 23 School A Concepts and Themes, Follow-up Interviews

Themes	School A – Phase 1 Concepts	School A – Phase 2 Concepts	Themes
School Subject	Maths skills iSTEM skills 3D printing Integrated Creativity Technology	Humanitarian side of engineering. Engineers without borders Engineering mindset Design languages Respect Honour	**Insight**
Vocational / Technology Discipline	Mindsets on working Modern Engineering Engineering, more of a physical thing.	Optimising manufacturing Get products cheaper but higher quality.	**Efficiency / Improvement**
Making / Creating	Make the projects. Innovation Tech drawings Practical	Simplistic design Interest Interactive elements	**Making / Creating**
Learning	Teacher to class session Learn by doing (stuff) Whole theory sessions How stuff works Class time Understanding	Memory skills Intelligence Understand	**Learning**
Value Perception	Enjoyable Future job career choice Future careers Job opportunity Global impact	This cell is left intentionally blank.	
Culture	Empathy for culture Know people / religion / beliefs Share technology / ideas Technology alliances		

Follow-up interviews for School A produced notable additions to concepts recorded in concept maps. It was possible to find the same themes as those found in concept maps, and the same or similar concepts associated with them. As shown in Table 23 above, additional themes for Phase 2 included,

- Making / creating
- Culture

The theme of ‘making / creating’ again consolidated the conceptualisation that students have with respect to their involvement in the related theme of learning. Their involvement appears not to be a separated, or detached process. Not immediately present in the concept maps, but far more easily identifiable in follow-up interviews is the concept of culture. The participants could conceptualise culture and assign attributes of empathy, knowing, belief, ideas, and alliances. Participants did not verbalise that they were not able to represent those concepts in concept

maps but were able to recall and associate them in their conceptualisation of iSTEM when prompted. This has implications for the teacher which will be explored further in the discussion chapter.

Phase 2 concepts did reflect two new themes not identifiable in concept map analysis.

- Insight
- Efficiency / improvement

As participants reflected on their concept maps, the concept of efficiency / improvement was indicated by notions of ‘optimising manufacturing’ and ‘making cheaper and higher quality products’. At high-level, these concepts may be broadly associated with the natural evolution of technology generally. However other concepts did not fit into previously identified themes and represented a divergent line of thinking. Participants became much more attuned to the effects on, or implications for STEM/technology as a vocation/discipline on society. Human impact emerged as a factor. The theme of ‘insight’ was assigned to these conceptual reflections as participants appeared to being thinking on a wider level than they had previously considered. Four concepts stand out:

- Humanitarian side of engineering
- Engineering without borders
- Engineering mindset
- Design languages

These conceptualisations resonate with the concept found in concept maps of ‘non-traditional engineering jobs’. How these conceptualisations may be related is addressed in Section 4.3 Proposition and Value Perception.

To assist the reader, a high-level summary of themes in this sub-section is provided in Table 24 below.

Table 24 Section 4.2.1 School A Themes High-level Summary

Research Question 1 Section 4.2.1 School A - Themes		
	Technology Participants	**Language Participants**
Phase 1	**Themes of:** • School subject • Vocation / technology discipline • Making / Creating • Learning • Value perception • Culture.	There were no languages participants at School A.
Phase 2	**Themes of:** • Vocation / technology discipline • Learning	

4.2.2 School B - concepts and themes

Concept Maps – Phase 1

Concepts and themes identified in School B concept maps are shown in Table 25. The table separates the data between technology and languages participants. Technology participants produced eighty-three identifiable concepts against languages participants' 59. Table 25 presents the concepts after adjustments for duplicates and arrangement into themes as for School A.

Table 25 School B Concepts and Themes

Theme	School B – Concepts Identified in the Raw Data Technology Students Phase 1	School B – Concepts Identified in the Raw Data Languages Students Phase 1	Theme
School Subject	subject at school STEM/iSTEM science problems thinking real world maths design technology assignments subject choice fluid subject	French school marks / ATAR	**School Subject**
		community everyday life is connected communication knowledge words history temples empires culture & difference cultural understanding social issues interesting culture food, culture, language identity	**Culture**
Creating / Making	practical /hands on design building ergonomics physical design design process digital design machinery		
Value Perception	future career opportunities friends doing DT what I value	job opportunities benefits Learning with a different part of the brain. fun, enjoyable Ability to communicate with foreigners. social life	**Value Perception**
Reasoning	formula reason behind building thinking for the future data critical thinking where / why conceptual design reality (of class experience) solving big issues creative thinking how understanding thought process innovation	understanding the world why (did I join)?	**Reasoning**
		mother tongue French learning a language understand language use understanding differences knowing the language	**Language**
Vocation / Technology Discipline	work / job electronics what the client wants Elon Musk Tesla 3D printing/design/structures military hardware research testing technology building engineering programming computing	This cell is left intentionally blank.	This cell is left intentionally blank.

Theme	School B – Concepts Identified in the Raw Data Technology Students Phase 1	School B – Concepts Identified in the Raw Data Languages Students Phase 1	Theme
Motivation / Aspiration	global exploring	wanderlust inspire geography	**Motivation / Aspiration**
Learning	teacher to class learning learning new skills grades	reading writing speaking changes the way your brain works community in class learning about others ability to learn challenge	**Learning**

Similar to School A, concepts are presented mostly as one word with some listed as two or more words, or groups of words. Reasons for multi-word concepts appear to follow the same logic as for School A, e.g., similarities, related constructs.

The findings indicate that participants at School B responded to the focus questions with similar concept morphology to School A. There was consistency in that concepts were drawn as large single words, linked with drawn lines/arrows to smaller, subordinate words, groups of words and/or phrases. Figure 24 below demonstrates a typical example from a technology participant.

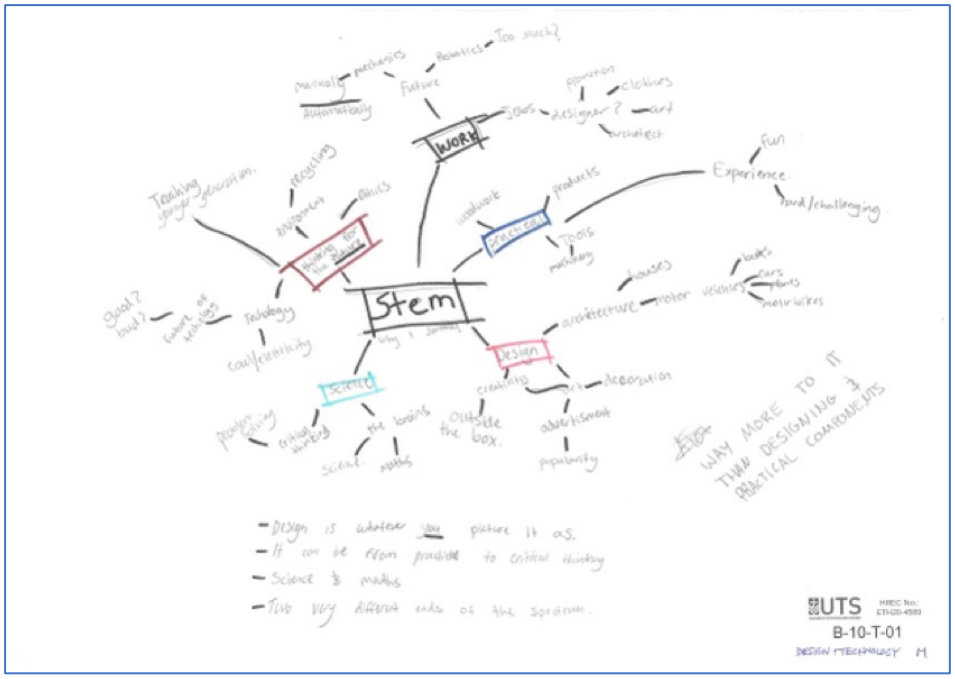


Figure 24

Some variation existed in approaches to concept map creation in School B participants. This is also consistent with School A participants, and this variation did not appear to influence participants' ability to conceptualise their subjects or complete the task. Figure 25 demonstrates an example whereby a technology participant used the same structure of words (and groups of words) connected by lines/arrows, but with the addition of a row and column structure.

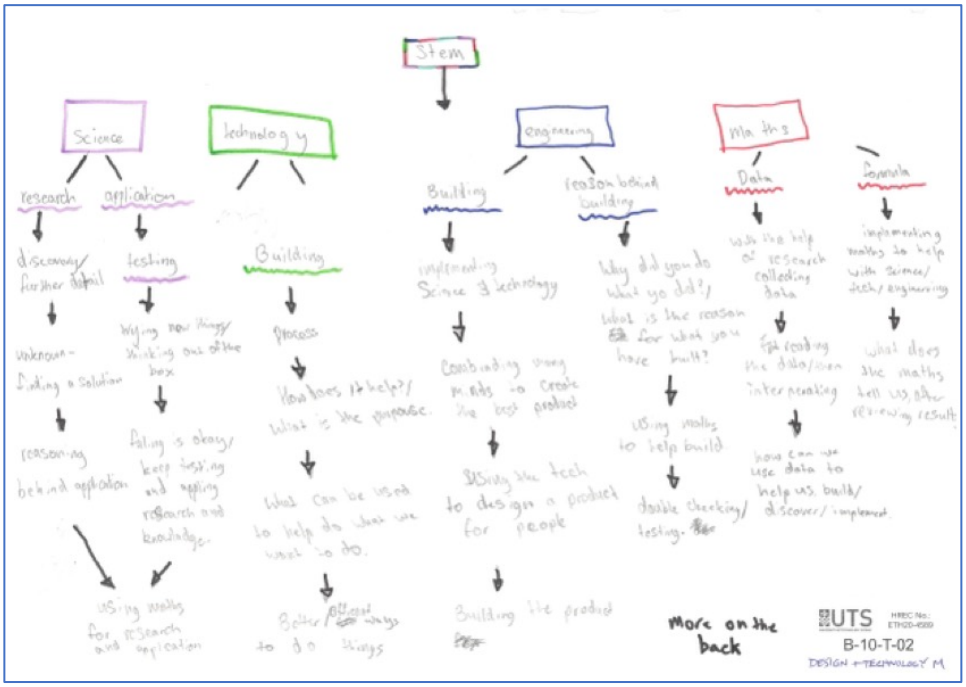


Figure 25

In both cases, concepts were clearly identifiable using the concept map overlay process outlined in Chapter 3.

Languages participants also followed the same general structure as technology participants, indicating consistency across cohorts. A noticeable variation is the level of detail used by languages participants in the words written onto the concept map. Languages participants tended to use short expressions more readily, resulting in a greater volume of words generally. Figure 26 below demonstrates a typical example of the similarity between School B languages and technology participants. Note the similarity with Figure 24 above.

The use of sketched images for technology participants was significantly limited in School B concept maps. Recognisable images such as brand names or logos were absent in School B concept maps. Languages participants tended to use sketches more readily when producing concept maps, however, these variations did not limit participants' capacity to clearly communicate concepts.

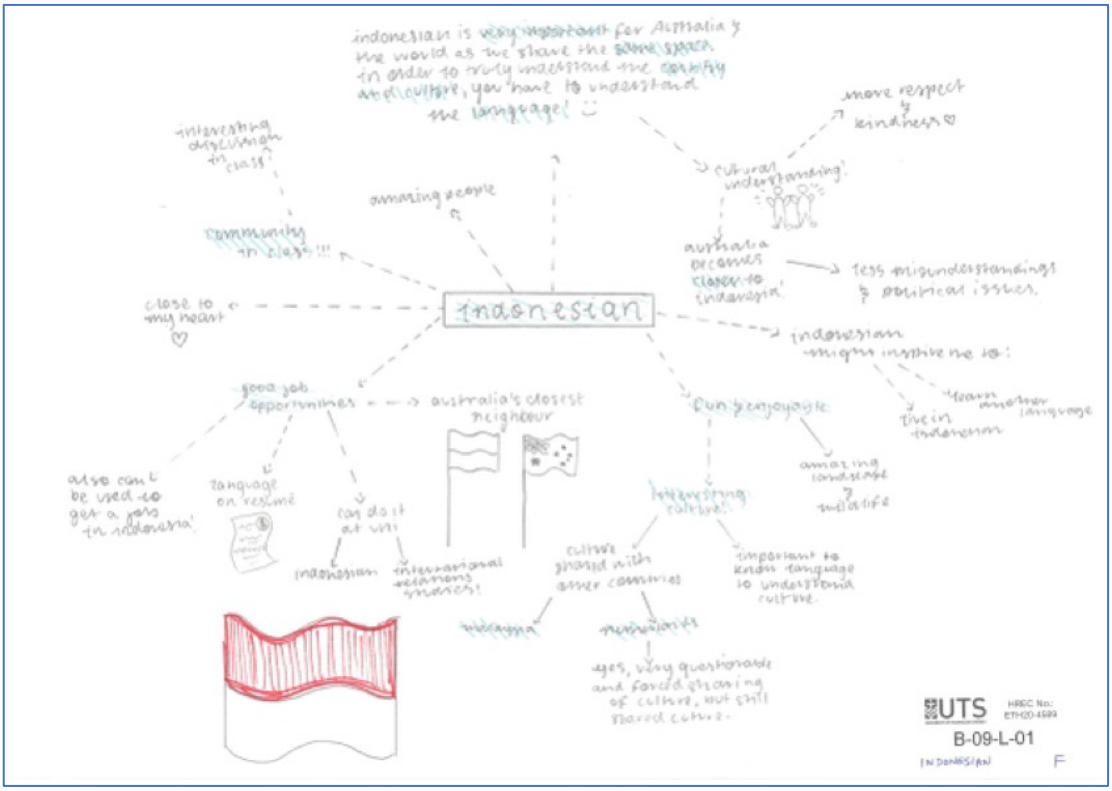


Figure 26

School B concept maps produced two responses which are noteworthy for their detail. Complexity of the concept map, detail in sketches and depth in concepts, relationships and propositions stated are all clearly higher. Figure 27 below is a Phase 1 concept map which indicates a strong understanding of the concept map creation task, even including a legend to

indicate linkages and levels of importance within the map (indicated by the superimposed blue arrow).



Figure 27

Figure 28 illustrates a similar example with strong use of colour and imagery to help convey the response. The concept map also demonstrates a strong use of text in the form of short statements and sentences.

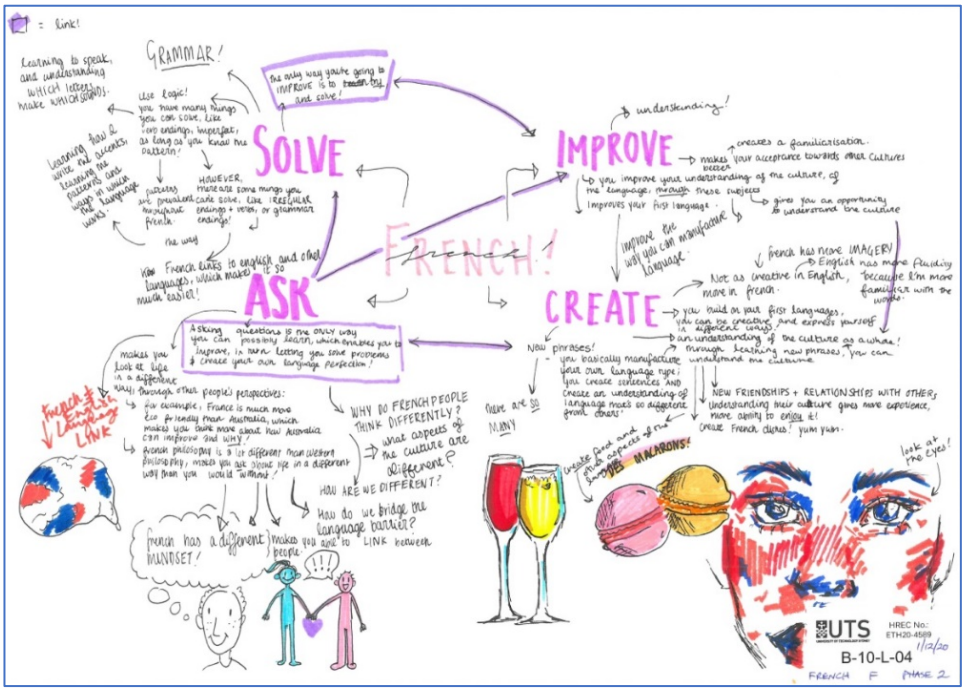


Figure 28

Whilst Figure 27 and Figure 28 above present striking visual responses, they are considered equally against all other concept maps for the purposes of investigating conceptualisation. A more visually impactful concept map is not considered more correct. To further illustrate this distinction, Figure 29 below is provided as a comparison.

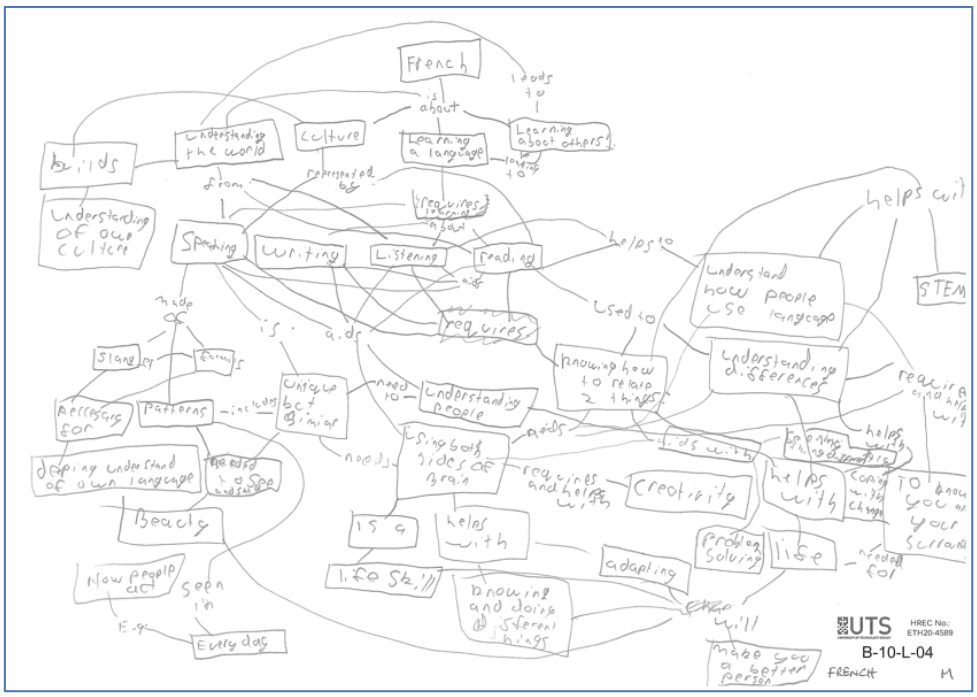


Figure 29

Figure 29 above contains no imagery or colour. However, the same underlying structure of larger words depicting concepts, accompanied by subordinate words and phrases is still present. This participant is still able to present a conceptualisation of languages.

Themes arising from Phase 1 concept maps were similar for School B technology and languages participants. A summary is provided in Table 26 below.

Table 26 School B Phase 1 Themes, Technology & Languages

Theme School B – Phase 1 Identified in the Raw Data Technology Students	Theme School B – Phase 1 Identified in the Raw Data Languages Students
School Subject	School Subject
Creating / Making	**Culture**
Value Perception	Value Perception
Reasoning	Reasoning
Vocation / Technology Discipline	**Language**
Motivational / Aspirational	Motivational / Aspirational
Learning	Learning

Themes not in common between the two groups (indicated in bold) include the two technology themes of 'creating/making' and 'vocation/technology discipline', and the languages themes of 'culture' and 'language'. These themes potentially speak directly to the differences between the subjects: technology and languages. However, there are strong common themes between the two groups. Whilst there are clear indications that participants recognise how the subjects could be themed as 'school subject', participants do also recognise latent themes of value perception, reason, motivation, and aspiration. Both groups also communicated a strong awareness of 'learning'. Participants have a concept that their subject is an experience of learning, either through direct interaction with their teachers, skills acquisition, or by noticing changes within themselves ('how their brain works').

Since participants were asked to consider value perception specifically in the focus questions presented to them, the theme of value perception as a conceptualisation was expected. However, supporting the theme of value perception was the identified theme of 'reasoning' which was not evident in conceptual themes for School A. Examples of concepts expressing the theme of reasoning for technology students include,

- Reason behind building
- Thinking for the future
- Reality (of class experience)
- Solving big issues
- Creative thinking
- Thought process.

These conceptualisations suggest that students not only attend classes to learn subject matter but come to classes with expectations wider than learning curriculum content. The content

learned in class becomes the vehicle by which students can search for and express the 'reasons behind building' or solve big future issues.

Languages participants also indicated conceptualisations of reasoning with examples including,

- Understanding the world
- Why (did I join)?

These conceptualisations are supported by languages' participants conceptualisations of culture, where a much wider expression is indicated than just learning a foreign language. Examples include,

- Everyday life is connected.
- Culture & difference
- Cultural understanding
- Social issues
- Identity

Similar to technology participants, there is evidence that students bring to class a concept of their subjects that is not limited to their immediate context. Future value through 'careers' and 'job opportunities' is commonly cited, indicating that students already look beyond their subjects to the world that awaits them.

Concept Maps – Phase 2

School B Phase 2 concepts and themes are provided in Table 27 below.

Table 27 School B Phase 2 Concepts and Themes

Themes	School B – Concepts Identified in the Raw Data Technology Students Phase 2	School B Concepts Identified in the Raw Data Languages Students Phase 2	Themes
School Subject	design and tech theory & practice fluid subject	French Language knowledge	**School Subject**
Creating / Making	design different ideas creativeness building stuff creativity	create	**Creating / Making**
Value Perception	job opportunities future jobs fun, social	Connection benefit of the subject brain break future layering skills skills improve creativity	**Value perception**
Reasoning	Understanding innovation improvements intelligence across subjects	Ask Solving improve	**Reasoning**
Learning	learn applying learning life skills applying understanding learning abilities analytical	Learning more (about culture)	**Learning**
Culture	connect world view principles	culture country Friendship Traditions History Society Food Beliefs Attractions Fashion Unity Understanding empathy	**Culture**

School B languages participants offer the first glimpse into whether alternate value propositions found in technology participants' conceptualisations had any impact on languages participants, and vice versa. Overall, the quantity of concepts identified was less for both groups. This potentially indicates a consolidation of previous conceptualisations, or the emergence of data saturation. When adjusted for duplicates, the concepts identified could be arranged into the same themes as for Phase 1 with one new reference to the theme of 'making / creating'. The presence of the concept of culture did appear more prominently in both technology and

languages responses. A slight shift occurred for technology participants as they began to record notions of ‘connection, world view and principles’. Languages participants further consolidated their cultural conceptualisations with additional notions of ‘friendship, traditions, beliefs and unity’.

Noteworthy in the Phase 2 concept map data was that technology participants produced far fewer conceptualisations relating directly to technology as a school subject. However, the theme of ‘learning’ continued to be evident. Moreover, the theme of ‘culture’ could be identified in the data for technology participants. Concepts such as ‘world view, principles and connection’ were recorded. This could be because the Phase 2 focus questions simply prompted participants to write down these words. Alternatively, the shift in thinking could have been a genuine attempt to re-conceptualise technology as a subject.

Another potential indication of impact on technology participants by languages participant conceptualisations, is the inclusion of ‘intelligence across subjects’. Located in the theme of reasoning, it provides evidence that participants began to consider technology not only from a wider perspective outside of their immediate school context, but also within the context of learning other subjects. This is addressed further in the context of findings related to propositions.

By contrast, languages participants focussed more on culture and language, although not the components of languages per se such as reading, writing, speaking, and listening. The components of languages participants conceptualisations were far ranging, including,

- traditions
- history
- beliefs
- empathy

In addition, Phase 2 languages concept maps also displayed stronger focus on propositions, suggesting a more immediate connection with or recognition of value propositions. This shift to focussing on propositions in Phase 2, and the shift in focus for technology participants is discussed further in Section 4.3 Propositions and Value.

Follow-up Interviews

Concepts and themes identified in follow-up interviews for School B Phase 1 and Phase 2, technology and languages participants are shown in Table 28 below (see also Appendix J). The table presents the data in groups of participants. In some cases, technology and languages participants were mixed in the same group. Due to reasons of scheduling, it was not possible to separate all participants into discrete technology and languages groups. This is not considered a hindrance to the reliability of the data as follow-up interviews were not intended to be the

primary data source. Mixed groupings notwithstanding, the interviews did produce valuable data. Since the groups are mixed, it is possible to present Table 28 with Phase 1 and Phase 2 side by side.

Table 28 School B Phase 1& 2 Concepts and Themes, Follow-up Interviews

Themes	School B – Phase 1 Identified in the Raw Data Concepts	School B – Phase 2 Identified in the Raw Data Concepts	Themes
Group B01 – Languages students		**Group B01 – Languages students, 4 year 10, 1 year 9**	
Value Perception	Opportunities Jobs Intelligence and overall knowledge.	Creativity Intrinsic motivation Connection	**Motivation / Aspiration**
Learning	What we're learning. How we're reading it. How we're writing. How we're learning to speak	Learning new skills Improving old skills Learning new words Practising specific phrases Learning the word tenses Structure Skill	**Learning**
Culture	Communication Culture Aspects of culture. Think in Indonesian. Lost in translation. Values		
Group B02 – Languages students, plus DT Teacher.		**Group B02 – 4 year 10, 3 year 9 Design and Technology.**	
Learning	Critical thinking Creative thinking	Intelligence across the subjects Time management research skills Writing skills Understanding Both sides of the brain Learning Problem solving	**Learning**
Culture	Culture Self-expression Connection	Fun Enjoyment	**Value Perception**
Making / Creating	Human-centred design Empathetic design Authentic design		
Motivation / Aspiration	Preferred future Altruistic motivation Social issues		
Language	History of the language		
Group B03 – 6 year 9 Design and Technology students		**Group B03 – 6 year 9 French students, 1 year 10 Russian student (via Zoom)**	
Making / Creating	Linking Design process Conceptual design Hands on Problem solving Making stuff Machinery Emerging technologies	Learn new skills Vocabulary Writing Listening Speaking Boredom	**Learning**

Themes	School B – Phase 1 Identified in the Raw Data Concepts	School B – Phase 2 Identified in the Raw Data Concepts	Themes
	Digital design Commerce Art Risk taking		
		Occupational Create new opportunities. Open up new doors	**Value Perception**
Group B04 – 6 year nine French students		**Merged with other groups for Phase 2**	
Value Perception	ATAR Beneficial Occupation Social life		
Culture	Language (and culture) Food (cuisines) Art (within the culture) Vocabulary History		
Group B05 – Year 10. Four D&T students, two French students.		**Merged with other groups for Phase 2**	
Value Perception	Future Factors influencing my selection. Future jobs		
Making / Creating	Ergonomics Design technology Thinking outside the box Conceptualising design Imagination		
Culture	Communication Travel Words Culture Understanding people		

From a thematic perspective, the follow-up interviews continue to consolidate findings in concept maps. However, for the groups represented in Table 28, no additional themes were identified. There is a notable component in the theme of ‘making / creating’. Allocated to technology students, this theme includes components broadly expected with technology subjects such as,

- hands on
- making stuff
- problem solving
- machinery
- emerging technologies

In addition to the above, there were two further components of,

- art
- risk taking.

These were not obvious in the concept maps. They appear only once and are noted for their potential relationship with value perception, explored further in Section 4.3.

Phase 2 interviews indicate a declining number of conceptualisations which indicates possible data saturation. The conceptualisations were similar in components and themes to those identified in Phase 1, with no new themes emerging. Despite the lower number of data points, it is noteworthy that the themes identified in Phase 2 are dominated by 'learning' and 'value perception'. It can be drawn from this that participants have a clear concept that their subjects will enable, or provide opportunity to learn, which in turn provides future opportunities. These opportunities are mostly connected to jobs or careers.

To assist the reader, a high-level summary of themes in this sub-section is provided in Table 29 below.

Table 29 Section 4.2.2 High-level Summary

Research Question 1 Section 4.2.2 School B - Themes		
	Technology Participants	**Languages Participants**
Phase 1	**Themes of:** • School subject • Making / Creating • Value perception • Reasoning • Motivation / Aspiration • Learning	Themes of: • School subject • Culture • Value Perception • Reasoning • Language • Motivation / Aspiration • Learning
Phase 2	**Themes of:** • Culture	**Themes of:** • Creating / making

4.2.3 School C - concepts and themes

Concept Maps – Phase 1

Concepts and themes identified in School C concept maps are shown in Table 30. As for School B, the table separates the data between technology and languages participants. Technology participants produced 7 identifiable concepts and languages participants' 22. Table 30 presents the concepts after adjustments for duplicates and arrangement into themes as for Schools A and B.

Table 30 School C Concepts and Themes

<table>
<tr><th>Theme</th><th>School C Concepts
Identified in the Raw Data
Technology students
Phase 1</th><th>School C Concepts
Identified in the Raw Data
Languages Students
Phase 1</th><th>Theme</th></tr>
<tr><td>Reasoning</td><td rowspan="2">thinking
reality
aptitude
change</td><td>gain perspective</td><td>Reasoning</td></tr>
<tr><td>Making / creating</td><td rowspan="2">To value
Value (nominated as a concept)
personal interest
(gain life) experience</td><td>Value Perception</td></tr>
<tr><td colspan="2" rowspan="4">This cell is left intentionally blank.</td><td>creativity
creating
interest</td></tr>
<tr><td>understand (how we use language)
(experience other) cultures
spread of culture
Influences
travel
food</td><td>Culture</td></tr>
<tr><td>help other people
provide opportunities
To help
impact
inspire</td><td>Motivation / Aspiration</td></tr>
<tr><td>To communicate
To connect
(meet and) connect (with people)</td><td>Communication</td></tr>
<tr><td></td><td>way of learning
So, is it just a tunnel?
draws influence</td><td>Learning</td></tr>
</table>

School C concepts are fewer in number than those for Schools A and B. Technology participants at School C numbered only 2 and languages participants numbered 10, resulting in fewer data points overall. Similar to Schools A and B, concepts were presented as one or two words, or groups of words. The logic for grouping words also appears consistent with Schools A and B. It should be noted that School C participants responded to focus questions that were influenced by Phase 2 responses from Schools A and B. The reduction in number of data points and range of responses compared with Schools A and B indicates that School C participants did not materially add to conceptualisation data collected: an early indication of data saturation.

Morphology of concept maps for School C is consistent with those for Schools A and B. They follow the same general structure of concepts shown as larger words connected by drawn lines/arrows to subordinate words, phrases, or short sentences. Figure 31 demonstrates a typical School C concept map.

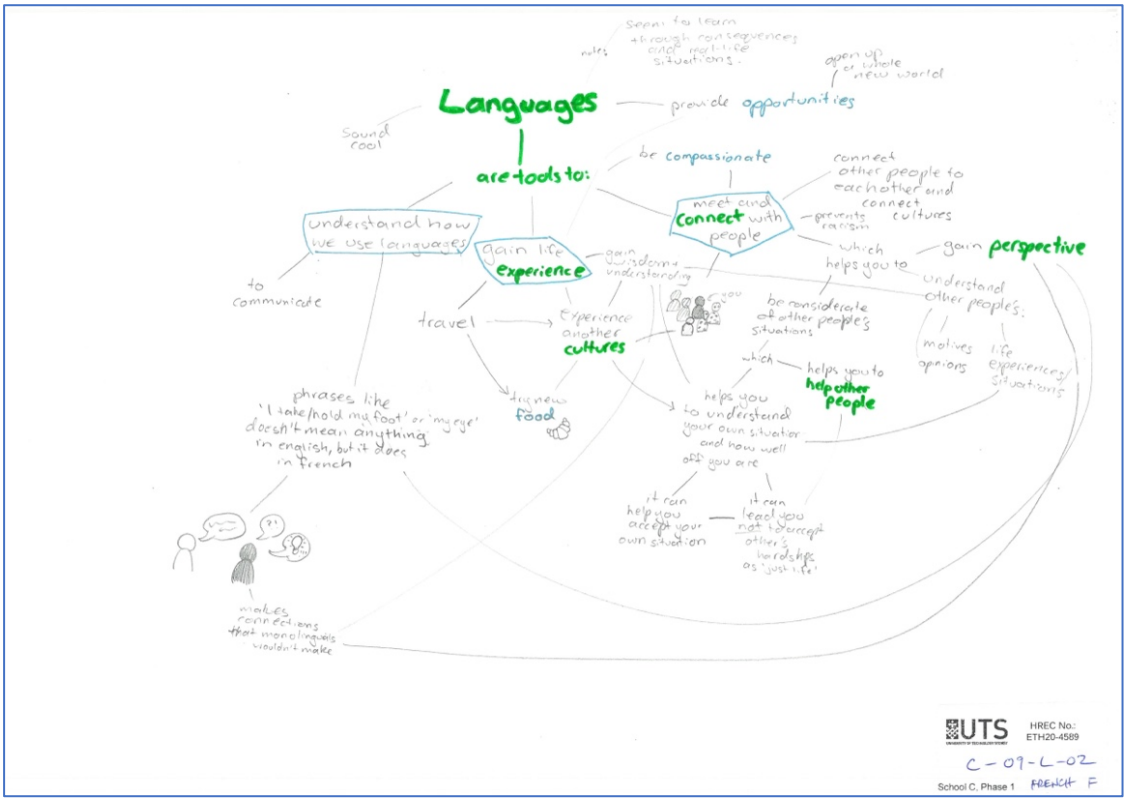


Figure 30

Some variation occurred in School C concept maps similar to School B in that several participants produced responses that are visually striking. Strong use of colour, images and sketches was utilised to conceptualise the subjects. In Figure 31 below, an example is shown where colour and imagery also resulted in significantly fewer words being used to complete the task.



Figure 31

In stark contrast to Figure 31 above, Figure 32 below illustrates a languages participant response with no use of colour or imagery and a much more complex use of drawn lines to connect concepts, relationships, and propositions.

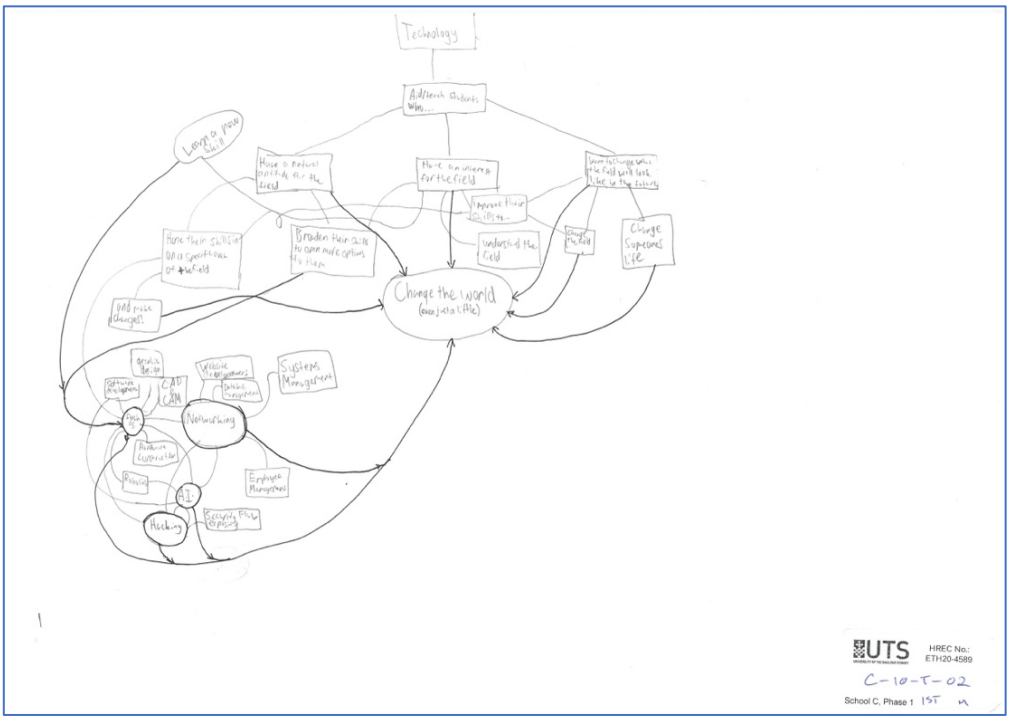


Figure 32

These contrasts, however, are not considered outliers across the whole data set for Schools A, B, and C, as participants generally produced concept maps of similar morphology. Concepts

could also be identified across this range of responses using the overlay method described in Chapter 3.7. As previously stated, concept map morphology is not being assessed for correctness in this study. Each concept map is considered equally for the purposes of identifying conceptualisation. This is also explored further in Section 4.2.4 Synthesis of Concepts and Themes - Schools A, B and C.

The smaller number of technology participant conceptualisations also produced fewer identifiable themes, with only two emerging. Conceptualisations produced by languages participants resulted in a similar number of themes to School B Phase 1 responses, with similar themes also present. They are summarised in Table 31 below.

Table 31 School C Themes

School C Themes Identified in the Raw Data Technology students Phase 1	School C Themes Identified in the Raw Data Languages Students Phase 1
Reasoning	Reasoning
Making / Creating	Value Perception
	Culture
	Motivation / Aspiration
	Communication
	Learning

Whilst fewer in number, the themes present in technology participant responses were similar to those for Schools A and B. However, the fact that fewer themes were identifiable suggests that not all students share the same number or diversity of conceptualisations. The conceptual components associated with practical technology subjects like ‘designing’, ‘constructing’, ‘hands-on’ and ‘making stuff’ were absent in the responses. This is potentially related to the fact that these technology participants were studying Engineering Studies and Information Software Technology. They are both technology subjects that require practical outputs; however these outputs are not obvious in the conceptualisations. Linked to this is the appearance of ‘Reasoning’ as a theme in these technology responses. Components for the theme of reasoning included,

- thinking
- reality
- aptitude
- change

Notable in this list is the theme component of ‘aptitude’. The component appears only once in Phase 1 data across Schools A, B and C. This is the first indication that a student considers aptitude as a capability that the student can bring to the subject, or needs for the subject, rather

than the subject offering a value proposition to the student. This also has implications for the teacher which will be explored in Section 4.2.5 How Students Conceptualise Their Subjects.

Phase 1 languages participants produced conceptualisations resulting in very similar themes to School B. The themes of value perception and learning appear as for School B and are strongly supported by the theme determined as 'motivation/aspiration'. Consider the components of the themes for 'value perception' and 'motivation/aspiration' summarised in Table 32 below.

Table 32 School C Themes, Phase 2, Languages

School C Themes Identified in the Raw Data Languages			
Motivation / Aspiration	Help other people. Provide opportunities. To help impact inspire	To value Value (nominated as a concept) personal interest (gain life) experience	**Value Perception**

The component of 'opportunities' listed under the theme of motivation/aspiration also appears as a value perception component in the School B responses. However, in this case, the component is better suited to motivation given the context of how these components were represented on concept maps. This suggests that participants possibly consider the opportunity to help, impact and inspire other people as valuable. Taken together, these themes and their components could potentially be considered more as altruism. Further exploration of 'propositions' for these participants in Section 4.2.5 will address this possibility.

Concept Maps – Phase 2

School C Phase 2 concepts and themes are provided in Table 33 below.

Table 33 School C Concepts Phase 2, Technology & Languages

Themes	School C – Concepts Identified in the Raw Data Technology Students Phase 2	School C Concepts Identified in the Raw Data Languages Students Phase 2	Themes
Learning	Learn Learning abilities fun to learn Memory / Perception Understanding	Learn new skills. learn ask (technology) skills / techniques know Improve skills, memorisation, comprehension, reading/writing	**Learning**
Technology discipline	investing in new technologies	confidence (language) learn new perspectives (language) literacy	**Languages**
Connection	Deep connection to technologies Communication Time	encountering cultures make connections. communication / expression communicate (language) Others	**Connection**
Motivation / Aspiration	Helping others Expression Connection	Improvements Improve / make better. Change Change, the world (technology) Helping others express the world interested experience	**Motivation / Aspiration**
This cell is left intentionally blank.		future focus lifestyle (change of) jobs travel interests To grow (language) Future, person, and society the future.	**Value Perception**
		to design creativity to solve problems creativity (technology) to design (technology) To make / build. Solve problems. Make, build, design, solve, Improve	**Design / Create**
		Food Cuisine Culture Wisdom Explore culture.	**Culture**
		Wisdom Use logic Logic Similarities, new skills, logic, improve. Differences, to make, solve, be creative.	**Insight**

School C Phase 2 concept maps produced a significant increase in conceptualisations for both technology and languages participants. Approximately 11 conceptualisations across 4 themes were identified in technology participant responses and approximately 50 conceptualisations across 8 themes in languages participant responses. The quantities are described as approximate as the components of themes in some cases were very similar, although possibly distinct. Examples include,

- Learn...learn new skills.
- Skills...Skills / techniques
- Improvements...improve/make better.

These similarities did not impact the identification of themes in the aggregate and still provided a reliable base from which to identify themes.

School C Phase 2 technology participant responses indicate that participants were influenced by the Phase 2 process. Concept maps indicate a distinct presence of new themes including,

- learning
- technology discipline
- motivation / aspiration
- connection

It is possible that propositions presented in Phase 2 focus questions prompted technology participants to consider the learning opportunities more deeply in the context of technology subjects, Moreover, that Phase 2 focus questions generated greater reflection on cognitive function, ‘memory/perception’, and insight, ‘perception’. These conceptualisations do not suggest improvement in cognitive ability or academic performance. Rather that students have become more aware that these changes can take place throughout the learning process in their subjects, or at least in the languages participants’ subjects. That is, students can ‘learn’ within their subjects, rather than simply ‘do’ their subjects.

The theme component of ‘connection’ is also located into two themes for technology participants: ‘connection’, and ‘motivation/aspiration’. The location is shared because the conceptualisation appears to reflect connection with the technology, and the motivation to use the technology for greater purpose or effect. How this translates into propositions is explored in Section 4.3 Proposition and Value Perception.

In contrast, languages participants responded with a high volume of conceptualisations for Phase 2 similar to Phase 1. Two further themes were identified,

- Design / Create
- Insight.

The addition of ‘design / create’ is noteworthy, as the components within this theme are not typically related to learning languages. These include,

- to design
- creativity
- to solve problems
- creativity (w/ technology)
- to design (w/ technology)
- To make / build.
- Solve problems.
- Make, build, design, solve, improve.

No assumption is being made that the presence of these data indicate a direct connection between languages and technology, or that languages participants would be inclined to undertake technology subjects. However, it can be said that languages participants may be considering the implications of considering the conceptualisations perceived by technology students. This is potentially linked to the emergence of ‘insight’ as a theme. The inclusion of technology components in languages participants’ concept maps may indicate a line of thinking that languages participants had not previously considered. This can be seen in the components of,

- Similarities, new skills, logic, improve.
- Differences, to make, solve, be creative.

Participants appear to be using technology conceptualisations to perform simple ‘compare and contrast’ comparisons to better understand potential connections or relationships between the subjects. Coupled with these comparisons, the inclusion of components such as ‘wisdom’ and ‘logic’ perhaps indicate insight not previously held.

Follow-up Interviews

Phase 1 and Phase 2 data for follow-up interviews are presented in Table 34 below (see also Appendix K). Due to scheduling, participants remained in one mixed group of technology and languages participants.

Table 34 School C Concepts, Phase 1, Follow-up Interviews, Technology & Languages

Themes	School C – Phase 1 Concepts Identified in the Raw Data	School C – Phase 2 Concepts Identified in the Raw Data	Themes
	Group C01 - French, Engineering, IST students	**Group C01- French, Engineering, IST students**	
Culture	Spreading of culture	Skills	**Skills**
Vocational / technology discipline	Engineering		
Value Perception	Experience Opens up a lot of doors. Opportunities Future Travelling Future jobs The engineering perspective of opportunity with future projects.		
Motivation / Aspiration	Expression Understanding, the world Creativity Inspiration		

Phase 2 follow-up interviews produced far fewer data points than Phase 1, indicating that students had no further meaningful contributions to make. The researcher also noticed that participants appeared somewhat exhausted by the process as evidenced by less time required to produce concept maps and visible signs of fatigue. The duration of the follow-up interview was also accordingly shorter than for Phase 1.

Themes identified in Phase 1 concept map data were similar for technology and languages participants. In Phase 2 data, the data saturation process became evident as participants mainly conceptualised both subjects in terms of 'skills', and then proceeded straight to propositions in their communication. There appeared to be a desire to move directly to talking about what they valued and liked about their subjects, rather than speaking conceptually or in terms of structure or components of their subjects. These propositions are explored in further detail in Section 4.3 Proposition and Value Perception.

To assist the reader, a high-level summary of themes in this sub-section is provided in Table 35 below.

Table 35 Section 4.2.3 High-level Summary

Research Question 1 Section 4.2.3 School C - Themes		
	Technology Participants	**Languages Participants**
Phase 1	**Themes of:** • Reasoning • Making / Creating	**Themes of:** • Reasoning • Value Perception • Culture • Motivation / Aspiration • Communication • Learning
Phase 2	**Themes of:** • Learning • Technology discipline • Connection • Motivation / Aspiration	**Themes of:** • Languages • Connection • Design / Create • Insight

4.2.4 Synthesis of concepts and themes - Schools A, B, C

The preceding sections considered concepts and themes found in concept maps and follow-up interviews on an individual basis for each school. Consistency was found in concept map creation across all three schools with some variation and all responses were considered reliable sources for the investigation of conceptualisation. Qualitative content analysis of concept maps and follow-up interviews generated themes based on individual conceptualisations presented by participants. The volume of conceptualisations recorded by participants supported the reduction into themes to make a more synthesised view of the data possible. This view is made visible in Table 36 below which maps the themes across all three schools.

Table 36 Schools A, B, C, Themes, Phase 1 & 2

Themes	School A		School B				School C			
	Technology		Technology		Languages		Technology		Languages	
	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2
Vocation / Tech. discipline								Phase 2		
Learning								Phase 2		
School Subject										
Value Perception										
Create / Make / Design						Phase 2				Phase 2
Culture				Phase 2						
Reasoning										
Language										Phase 2
Motivation / Aspiration								Phase 2		
Connection								Phase 2		Phase 2
Communication										
Efficiency / Improvement		Phase 2								
Insight		Phase 2								Phase 2

The three schools are geographically diverse, located in three different cities across New South Wales (NSW) and The Australian Capital Territory (ACT). Whilst Table 36 above indicates that students at these schools present similar themes in conceptualisation of their subjects, it is acknowledged that the themes are unique to the participants in those schools. For example, at high level, Table 36 demonstrates a different pattern of themes arising in School C when compared with Schools A and B. Themes appear more scattered. It should be noted again that technology themes for School C also appear underrepresented in this table, however this is likely due to the low number of technology participants in the study at School C.

Themes are represented in the table in the order as they appeared during analysis. Themes are not listed in order of priority or significance. The red box superimposed over Table 36 suggests a concentration of themes common across all three schools. This is based on rows where themes are represented more densely than others by appearing along the row from left to right. This region is not considered conclusive and is based on ‘best fit’. It is anticipated that themes appearing within this region will provide a base for uncovering the strongest conceptualisations within the data. Supporting these data are those cells indicated by the label ‘Phase 2’. These cells indicate where a theme was not present in Phase 1 but appeared in Phase 2.

Table 36 clearly shows that new themes emerged for each school in Phase 2 data collection. Moreover, that new themes did not always appear in areas of strongest commonality as indicated by the red box superimposed over the table. Technology participants at School A and

C exemplify this finding. School A technology participants demonstrate strong conceptualisation in Phase 1 and 2 in the themes of,

- Learning
- School subject
- Value perception
- Create / Make / Design.

However, Phase 2 also includes the themes of

- Efficiency / improvement
- Insight

These two themes do not appear for School B, and only 'insight appears for School C. Conversely, the theme of 'reasoning' appears for School C but not School A. These differences are noteworthy as numbers for School A (5 participants) and School C (2 participants) were low, but the subjects were similar. School A participants were studying iSTEM and School C participants were studying Engineering Studies and Information Software Technology. The purpose of noting these distinctions in the context of Table 36 is that conceptualisation in the data presented needs to take these variances into account. Conclusions drawn about conceptualisation may otherwise be considered to lack substance.

Conceptualisation for languages participants needs to be addressed with the same logic with respect to themes appearing in Phase 1 and 2. School B languages participants are a case in point. Seven themes were identified in Phase 1 and only 6 in Phase 2. In Phase 2, the themes of 'language' and 'motivation / aspiration' were not present as they were in Phase 1. However, the theme of 'create / make / design' was present and is noteworthy since this theme is not readily associated with learning languages. The components within this theme require closer inspection to uncover whether re-conceptualisation potentially took place. Similarly, School C languages participants produced three more themes in Phase 2, however five of these themes were not present in Phase 1.

Table 36 provides high level themes which are useful for establishing conceptualisation. There is some indication of concentration within themes, however the pattern provided is not conclusive. Therefore, a closer inspection of the themes requires the components thereof to be considered more carefully for the nature of the conceptualisations offered, and how or if they changed between Phase 1 and Phase 2. In the following section, these factors will be considered across two broad points below, to arrive at the most conclusive answer to the first research question.

- Where the concentration of themes occurs across Schools A, B and C.
- Where new themes emerged in Phase 2

For context and ease of navigation, attention is drawn to the stage of the process for addressing findings as described in Section 4.1.1. The following Section (4.2.5) is located as indicated by the red arrow in Figure 33 below.

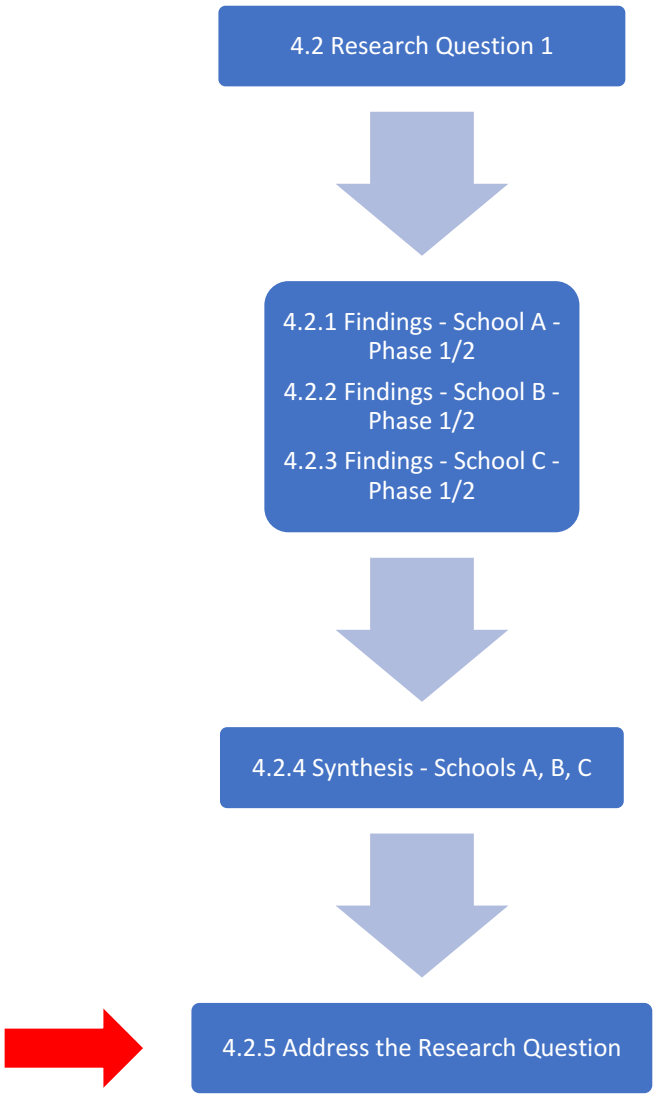


Figure 33 Section 4.2 Navigation

4.2.5 How students conceptualise their subjects

This section consolidates findings documented in Chapter Sections 4.2.1, 4.2.2, 4.2.3, 4.2.4, and addresses **Research Question 1**.

> How do students conceptualise the technology / STEM / languages subjects they study, independently from notions of assessment or curriculum?

Key statements are highlighted in Boxes 6, 7, 8, 9, and 10 to simplify the density of findings for ease of readability with respect to the research question. These key statements are referred to as the basis for discussion of conceptualisation in Chapter 5.2.

Participants in the study were able to offer conceptualisations of their subjects in accordance with the methods employed by the study. Given the diversity of data that could be expected from drawn concept maps and semi-structured interviews, the position taken by Prosser (1996, p. 25) requiring a clear methodology to "enhance the status and acceptability of image-based research" is noted for its applicability to this study. The clarity and structure of qualitative content analysis of concepts maps (Novak, 1995) and follow-up interviews produced visual and verbal units of meaning (Bell, 2004) that could be arranged into themes to represent conceptualisation. It is important to establish this as an outcome of the study as it provides evidence that participants were able to engage with the task to produce data that could address the research question.

> Participants were able to conceptualise their subjects after being prompted by focus questions designed to address the research questions.

Box 6

Concentration of Identified Themes

As described in the preceding section, themes identified in the study did show evidence of concentration in some areas. These include,

- Learning
- School subject
- Value perception
- Create / Make / Design
- Culture
- Reasoning

From the six themes listed above, the themes of

- School subject

- Create / Make / Design
- Culture

are considered to fall within an expected range of responses. Whilst no assumptions were made about how students would conceptualise their subjects, these themes are considered unsurprising in the data. For example, that a participant would identify their subject as something they do at school or label as a school subject does not appear out of place. Similarly, for participants to express a conceptualisation in terms of ‘design’, ‘make’ or ‘create’ appears as a natural association to make with a practical technology subject. The same logic is applied for the appearance of ‘culture’ as a dominant theme for languages participants.

The following themes were less anticipated in dominant themes.

- learning
- value perception
- reasoning

Whilst ‘learning’ may be considered synonymous with ‘students’ and ‘schools’, this theme is considered noteworthy as it suggests that students do have a concept, or expectation of learning. Moreover, that students do not merely think of their subjects as made up of content. This implies that students perceive the process of ‘learning’ as valuable; potentially as much as knowing the content itself. Table 37 presents the components of the theme for ‘learning’ for Schools A, B and C.

Table 37 Components of 'Learning' theme, Schools A, B, C

Theme: Learning	
School A Concepts Technology Students Phase 1	**School A Concepts Technology Students Phase 2**
Teacher to class session Learn by doing (stuff) Whole theory sessions How stuff works Class time Understanding	Memory skills Intelligence Understand
School B Concepts Technology Students Phase 1	**School B Concepts Languages Students Phase 1**
teacher to class learning learning new skills grades	reading writing speaking changes the way your brain works community in class learning about others ability to learn challenge
School B Concepts Technology Students Phase 2	**School B Concepts Languages Students Phase 2**
learn applying learning life skills applying understanding learning abilities analytical	Learning more (about culture)
School C Concepts Technology Students Phase 1	**School C Concepts Languages Students Phase 1**
Theme not present	way of learning So, is it just a tunnel? draws influence
School C Concepts Technology Students Phase 2	**School C Concepts Languages Students Phase 2**
Learn Learning abilities fun to learn Memory / Perception Understanding	Learn new skills. learn ask (technology) skills / techniques know Improve skills, memorisation, comprehension, reading/writing

Participants conceptualise their subjects as a place of learning.

Box 7

Table 37 indicates that participants conceptualise their subjects as a place of learning. Within the components listed there is evidence that participants see themselves interacting with and benefiting from the learning process through concepts such as,

- Teacher to class sessions / teacher to class learning
- Learn by doing
- Learning new skills
- Applying learning / applying understanding
- Learning abilities

Phase 2 responses also show early indication of reciprocal influence between technology and languages participants as they begin to include other high-level concepts within their overall conceptualisation. School A Phase 2 technology responses include deeper reflections on 'learning' indicating consideration of 'memory skills', 'intelligence', and 'understand'. Similarly, School C Phase 2 languages participants begin to consider the concepts of 'skills' (potentially as a language or technology skill), 'ask' (or inquire, with respect to technology), and 'techniques'. There is a utilitarian nature to the conceptualisation of 'learning' being presented. Students acquire capabilities.

Value perception was unexpected at conceptual level. However, its presence in the data suggests a link with the theme of learning. Given the practical nature of learning uncovered above, it follows that acquired capabilities could lead to tangible outcomes. Table 38 below provides the conceptualisations identified as being located within the theme of 'value perception'.

Table 38 Conceptualisations of Value Perception, Schools A, B, C

Theme: Value Perception	
School A Concepts Technology Students Phase 1	**School A Concepts Technology Students Phase 2**
Enjoyable Future job career choice Future careers Job opportunity Global impact	Theme not present.
School B Concepts Technology Students Phase 1	**School B Concepts Languages Students Phase 1**
future career opportunities friends doing DT what I value	job opportunities benefits Learning with a different part of the brain. fun, enjoyable Ability to communicate with foreigners. social life
School B Concepts Technology Students Phase 2	**School B Concepts Languages Students Phase 2**
job opportunities future jobs fun, social	Connection benefit of the subject brain break future layering skills skills improve creativity
School C Concepts Technology Students Phase 1	**School C Concepts Languages Students Phase 1**
Theme not present	To value Value (nominated as a concept) personal interest (gain life) experience
School C Concepts Technology Students Phase 2	**School C Concepts Languages Students Phase 2**
Theme not present	Creativity future focus lifestyle (change of) jobs travel, interests To grow (language) Future, person, and society, future

Whilst not present in all Phases or schools, there is strong evidence that participants perceive future value, and that there is a bias towards employment or career. Concepts identified include,

- Future job career choice
- Future careers
- Job opportunity / opportunities
- Job opportunities / benefits

Related to these concepts are the implied benefits of having capabilities for a career, including those listed as,

- Able to communicate with foreigners.
- (Gain life) experience
- Lifestyle (change of)
- Travel
- Future, person, and society...the future.
- Global impact

The concepts of 'fun / enjoyable' also appear in the theme of 'value perception' due to perceived value that enjoyment brings to quality of life. This is supported by the appearance of 'social' in both technology and languages participants. The benefits they perceive are not experienced in isolation, but within a social context.

Participants perceive value in their subjects,

- For themselves in the **present** through new learning.
- For themselves in the **future** through employment opportunities.
- For themselves in the **future** through lifestyle benefits.

Box 8

The third unexpected concept is 'reasoning'. Table 39 below indicates where this theme was present in the data.

Table 39 Presence of Theme: Reasoning, Schools A, B, C

Theme: Reasoning	
School A Concepts **Technology Students** **Phase 1**	**School A Concepts** **Technology Students** **Phase 2**
Theme not present.	Theme not present
School B Concepts **Technology Students** **Phase 1**	**School B Concepts** **Languages Students** **Phase 1**
formula reason behind building thinking for the future data critical thinking where / why conceptual design reality (of class experience) solving big issues creative thinking how understanding thought process innovation	understanding the world why (did I join)?
School B Concepts **Technology Students** **Phase 2**	**School B Concepts** **Languages Students** **Phase 2**
Understanding innovation improvements intelligence across subjects	Ask Solving improve
School C Concepts **Technology Students** **Phase 1**	**School C Concepts** **Languages Students** **Phase 1**
thinking reality aptitude change	gain perspective
School C Concepts **Technology Students** **Phase 2**	**School C Concepts** **Languages Students** **Phase 2**
Theme not present.	Theme not present.

The theme of ‘reasoning’ did not appear in School A data; however, it was evident in School B technology and languages participants, and School C technology participants in Phase 1. School B presented the strongest response with concepts labelled as,

- Reason behind building
- Thinking for the future
- Critical thinking
- Where / why
- Reality (of class experience)

- Thought process.
- Intelligence across subjects

As previously noted, School C also introduced the concept of ‘aptitude’ which occurs only once in the data across all three schools. School C also presents the concept of ‘reality’ in concept map data which is echoed in the School B response of ‘reality (class experience)’. This suggests that students bring with them a level of expectation and critique which is tied to their overall conceptualisation of the subject.

> Participants possess and express the ability to reason and make judgements about the subjects they study.

Box 9

New themes in Phase 2

Table 36, in section 4.2.4, indicates new themes emerging for participants in Phase 2 data collection that were not present in Phase 1. New themes occur both within and beyond the six themes where the strongest commonality among responses was observed. These themes include,

- Efficiency / improvement
- Insight
- Culture
- Create / Make / Design
- Vocation / technology discipline
- Learning
- Motivation / Aspiration
- Language
- Connection
- Skills

These themes did not appear for all participants. However, they are noteworthy because they emerged from participants being presented with modified focus questions based on responses from the alternate cohort. It is evident in the data that both technology and languages participants were able to consider conceptualising their subjects from an alternate perspective. Of note is that languages participants from Schools B and C were able to include the theme of ‘create / make / design’ in Phase 2, which is a theme typically expected to appear more readily in technology or practical based subjects. School B listed the concept of ‘create’ only once, however School C responses were more comprehensive, including,

- to design

- creativity
- to solve problems
- creativity (technology)
- to design (technology)
- To make / build.
- Solve problems.
- Make, build, design, solve, improve.

As high-level concepts occurring in School B Phase 2 languages responses, little in the way of conclusion can be drawn from their presence. It is more likely that their presence will have influenced Phase 2 propositions by School B participants, and this is explored further in Chapter 4.3. However, this does indicate an openness to considering the conceptualisations of participants studying other subjects as they consider their own; a finding explored in Chapter 4.5. The presence of these Phase 2 themes appearing also echoes the previous 'value perception' conceptualisation of 'intelligence across subjects' as presented by School B Phase 2 technology participants. This has implications for educators as they consider what conceptualisations students may bring to classes before tuition has commenced, and how they may benefit from cross-curricular collaboration. These implications are elaborated on further in the discussion chapter.

> Participants can consider other students' conceptualisations of other subjects, and how that may influence their conceptualisation of their own subjects.

Box 10

The six concepts listed as sharing strong commonality, and the three discussed in further detail above represent themes that are notable within the data. The three themes of 'learning', 'value perception', and 'reasoning' indicate that students have a 'concept' of their subjects that places them in an environment of learning, in which they engage and expect to be engaged. A consequence of this environment is that they acquire abilities that they perceive valuable for experiencing or receiving present and future value. It cannot be said from these data that all students in all contexts would share the same conceptualisation. However, the depth of responses present in these data suggest a high level of conviction in how these participants conceptualise their subjects.

4.3 Proposition and Value Perception - Research Question 2

Research Question 2 To what extent did value propositions offered by those subjects, and resulting from the conceptualisation strategy, motivate students to study those subjects?

Data reduction in Chapter 3 followed the process of identifying relationships between concepts indicated by drawn lines and written statements (Novak, 1995). These relationships lead to the further production of statements, or propositions that can convey specific meaning (Novak, 1995). The same procedure for qualitative content analysis of concept maps and thematic analysis of follow-up interviews, as described in Section 4.2, was used to address research question 2 in this section. Written statements (propositions) and themes in the raw data in response to the researcher's prompt for students to produce concept maps were identified. In the same way as for 'concepts' in Section 4.2, propositions and themes were further reduced to produce tables of themes and the components of those themes for Phase 1 and Phase 2 of the study. The same logic applied to follow-up interviews as described in Section 4.2. As for research question one, the propositions and themes identified in each school, via concept maps and follow-up interviews, are presented sequentially in Sections 4.3.1, 4.3.2, 4.3.3. The themes are then considered collectively to arrive at consolidated findings to address the research question in Sections 4.3.4 and 4.3.5. To support the findings discussed, selected tables from the reduced data are included in this chapter.

In the typical use of concept maps, propositions are statements that convey specific meaning about a topic or content that is considered to be 'correct'. In this study, propositions are derived from concept maps that allowed participants freedom from this criterion. Participants were also prompted by focus question two to specifically consider value perception. However, 'proposition' in the noun form has multiple definitions. It is therefore necessary to establish the nature in which 'proposition' was considered when evident on concept maps and in follow-up interviews.

For this study, the word 'proposition' is defined as "the act of proposing or a proposal of, something to be considered, accepted, adopted, or done" and "a thing, matter, or person considered as something to be dealt with or encountered" (Macquarie, 2024). Student participants make statements conveying specific meaning about their subjects that are considered, accepted, adopted, done, encountered, or illustrated. These are considered in the context of value, and how that value influenced decision making with respect to subject selection.

Distinction between research questions

At this juncture it is important to make a distinction between research questions 2 and 3.

- **Research question 2** – To what extent did value propositions presented by these subjects, and resulting from the conceptualisation strategy, motivate students to study those subjects.

- **Research question 3** – To what extent are there complementary value propositions between languages and technology subjects, and how do students express them?

The reason for the distinction at this point, is that the propositions shown in Phase 1 and Phase 2 data for Schools A, B, and C in this section may show complimentary value propositions. This section will focus on value proposition and motivation which is the subject of research question two. Section 4.4 will focus on complimentary value propositions, which is the subject of research question 3.

4.3.1 School A – propositions and themes

Propositions and themes identified in School A concept maps are shown in Table 40 below.

Table 40 School A Propositions and Themes, Phase 1 & 2

School A Propositions and Themes Identified in the Raw Data		
Theme	**Phase 1 Propositions**	**Phase 2 Propositions**
Value Perception	I value a logical answer. Enjoying STEM. Better living. Useful. Well spent. Not a waste of. Real life application. Reason I joined. Meet new people.	I am connected/interested in the lesson/topic we are studying. Use it to develop new and improved ideas. What I need to do to achieve goals. Connected Challenged Creativity Improving quality of life. Better understanding of others. Building high quality things for people rather than corporations. Future (appears as an endpoint in thinking) Fun (proposition, or random label) Job opportunities.
Reasoning	Why or how this could be done. How all the components fit together (if they do) Research and thoughts. I believe that each branch of STEM can help with a logical conclusion. Understanding of what a career in STEM or Tech would be like.	How and why things work. Able to explain things. Develop ideas. Link knowledge from my brain to be able to come up with new solutions. But through iSTEM you understand through the language of math and tech. Active. Being worked. Maths transcends language barriers. Universal understanding. Heavy cognitive load. Using engineering to solve big issues.
Learning	The teacher should lead the students rather than tell them what to do. Let students learn from examples rather than a textbook. (Reinforced with stick figure drawings) Learning skills without teacher help New ways to learn.	Growing interest in the world. Is similar to language, you are analysing the world. Real world skills. Learning to learn. Higher level of learning. Higher level of understanding. Challenging the brain. Gain understanding. Learn how to help others. Originality of texts in native language. New skills, improve skills.
Economic development	stronger economy opportunities for Australian miners government suppression of innovation leaders bad at communication future use, innovation	
Vocation / technology discipline		History of physics and engineering Engineering without borders Cheaper but higher quality manufacture

School A Phase 1 concept maps produced a range of propositions. The quantity is described as a range because proposition statements varied from single or multi-word representations to complete sentences. As previously stated, participants at School A were all iSTEM students. There were no year 9 or 10 students at the school studying languages.

The overall morphology of concept maps across Schools A, B, and C has been established as consistent for collecting data to address the research questions in the study. Propositions were identifiable in accordance with the methodology described in Chapter 3 and some variation was evident in the way propositions were recorded. In some cases, propositions occurred at the end of a series of connected elements. Whereas in other cases propositions occurred as a list of written statements separate from diagrammatic representations. Figure 34 below presents a section of an example where the proposition occurs at the end of a series of connected elements.

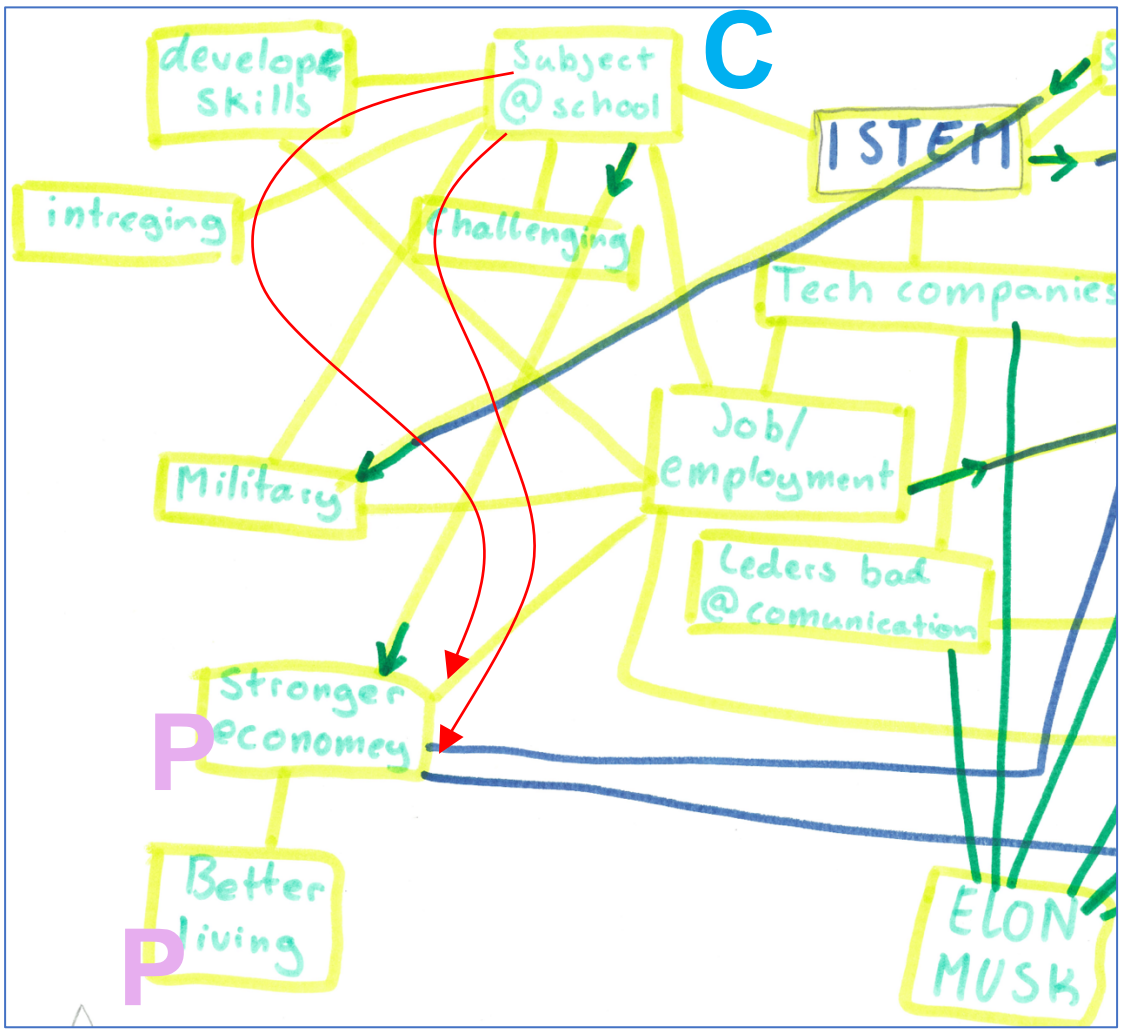


Figure 34

Figure 34 is overlayed with the labels 'C' (concept) and 'P' (proposition), and red lines/arrows indicating the flow of connected elements (relationships). 'Subject @ school' and 'job/employment' were identified as concepts in this response. The elements of 'develop skills', 'intreging' (integrating), and 'challenging' are observed to be connected in such a way as to lead to 'stronger economy' and 'better living'. Appearing at the end of the series of elements, and

communicating a thing to be considered, encountered, or affirmed attracted the label of P (proposition). That is, through the relationships of developing skills, ‘intreging’ (integrating) and being challenged, a ‘subject at school’ such as iSTEM can lead to the proposition of a ‘stronger economy’ and ‘better living’. Whilst ‘military’ is in the vicinity of the connected elements in this example, it is omitted due to its clear link with another element. Care was taken throughout the process of identifying propositions to account for complexity in how concepts were joined by relationships in concept maps illustrated with complex connections.

In contrast to Figure 34, Figure 35 below illustrates a participant response where propositions were listed as sentences separate from diagrammatic illustration.

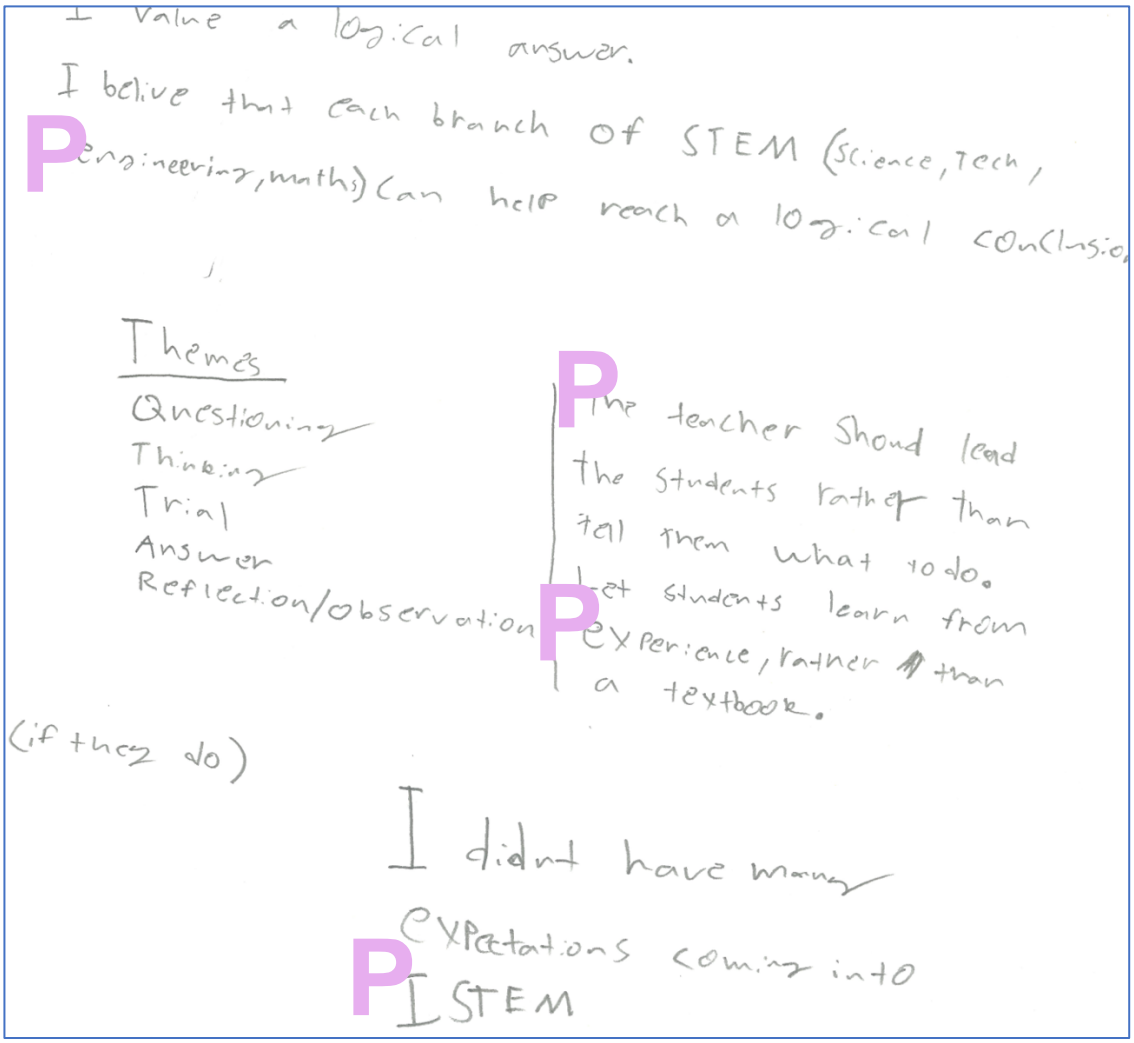


Figure 35

Figure 35 is overlayed with labels ‘P’ (proposition). These statements (units of meaning, (Novak, 1995)) are presented in the absence of lines or other diagrammatic elements that would indicate relationships between concepts. However, they are considered propositions as they clearly offer

a thing to be considered, adopted, or accepted with their use of high conviction language. Examples include *(italics added to indicate high conviction language)*,

- *I believe* that each branch of STEM (science, tech, engineering, maths) can help reach a logical conclusion.
- *The teacher should* lead the students rather than tell them what to do.
- *Let students learn from experience* rather than a textbook.
- I didn't have many expectations coming into ISTEM.

The diversity evident in Figures 34 and 35 indicate that participants were able to construct proposition statements in response to the research question. They were not limited by their abilities to produce graphical representations in the form of concept maps. School A Phase 2 concept maps produced similar responses in terms of morphology and expression of propositions. However, from Table 40 above, it is evident that Phase 2 produced more propositions than Phase 1.

Follow-up Interviews

School A Phase 2 follow-up interviews also produced more propositions than Phase 1 follow-up interviews (see also Appendix I). Table 41 below provides propositions for Phase 1 and Phase 2.

Table 41 School A Phase 2 Propositions and Themes, Follow-up Interviews

Themes	School A – Phase 1 Propositions Identified in the Raw Data	School A – Phase 2 Propositions Identified in the Raw Data	Themes
		The connection is really cool because there's a lot more in technology today than just getting the product as efficient as possible. I feel like especially Apple, you can see that they've put a lot of effort in making their operating system and their actual hardware seem a lot more alive. It's something that's quite approachable. Something that differentiates them a lot.	**Insight**
Learning	Enjoy learning by doing vs. worksheets. Teachers should lead kids in the right direction. Give them a direction to go on and give them basic skills to build on them, so they can get where they need to be. Can specifically do stuff that I enjoy. No other class that can let you do that for a major work. Help you understand why certain bits fit together. Progress further. So that they know what issues they face and what will actually help them. Everyone deserves their right.	I think feeling like you're doing something to help people would make students take more consideration in what they do in their projects. Not just making a project, they're designing something for someone. This project is fairly straightforward, and it doesn't have an impact. How could you build something that will benefit others? That'd be really good because I think that people would get involved in it. More enjoyable for them. So, enjoyment.	**Value Perception**
Culture	Need better languages courses in Australia. Benefited [benefits] people if you've got a population that can speak a wide array of languages. More attractive prospect. [moving to Australia] They are going to have an easier time. [immigrants]	They'll have a reason to do it and they'll have more motivation to do it. I spent a lot of time trying to work out. But in doing that it made it a lot nicer to use because it was more comfortable. I wanted to make it nice to use.	**Motivation / Aspiration**

Themes	School A – Phase 1 Propositions Identified in the Raw Data	School A – Phase 2 Propositions Identified in the Raw Data	Themes
Language	Imagine the amount of work that could be done if engineers from Australia were able to properly communicate with engineers from some other country who speaks a different language. Doing languages from early education, so even incorporating different languages into preschools.	So, there's obviously issues that engineering isn't the right thing to solve it with. And so, you got to also add into it alternate methods, not just sticking with what you got. They actually get able to enjoy what they've purchased if they do purchase something. Well, I believe most technology has been getting off track. But I feel like they should focus on user comfort. They risk quantity over quality. Making the projects a little bit more involved with connecting with other people and things.	**Insight**

The increase in propositions offered by School A participants in Phase 2 may indicate an influence from the revised Phase 2 focus questions. It may also merely indicate a familiarity with the concept mapping and follow-up interview process and therefore generate a sense of ease with providing responses. Regardless of whether either of these scenarios transpired, the content of themes identified and the components within those themes indicate depth in the responses.

Themes identified in School A participant propositions were broadly in line with themes arising from concepts (as described in Section 4.2.1). These include,

- Value perception
- Reasoning
- Learning
- Economic development
- Vocation / technology discipline.

Follow-up interviews did result in additional themes for Phase 1 and Phase 2 data. Additional themes appearing in Phase 1 included,

- Culture
- Language

Additional themes appearing in Phase 2 included,

- Motivation / aspiration
- Insight

Notable in the above list of themes is that culture and language appeared in Phase 1 but not Phase 2. However, the themes of 'motivation/aspiration' and 'insight' appear to be evident due to deeper consideration of factors related to value perception.

From a thematic perspective, participants communicated value in their responses. Aside from the specific theme of 'value perception', other themes present include,

- Reasoning
- Learning
- Economic development

and to a lesser extent,

- Vocation/technology discipline (Phase 2 only)

In the context of students studying subjects at school, the presence of statements about learning and reasoning are valuable in the sense that they could be expected in an ideal response from students. The themes of 'economic development' and 'vocation/technology discipline' have wider implications of value for society and are less specific to the participants themselves. However, to ascribe these themes to student perceptions of value that impact subject selection, a closer inspection of the responses is necessary.

The data indicate that the 'extent' to which value propositions presented by their subjects motivated them to take those subjects falls within two broad categories.

- Value to society and the world generally
- Value specifically to the student

Value to society and the world generally

To suggest that a student would elect to take a subject to add value to or improve society and the world may seem utopian and nebulous. However, the data indicate that participants can make clear links between their subject and its potential wider impact. In this case, the components of the value perception theme offer some support through propositions such as,

- Better living
- Improved quality of life
- Real life application
- Future

Whether the above propositions were recorded because of participants' authentic reflection, or the Zeitgeist of a better future, or marketing influences is uncertain. They are, nevertheless, present. Potentially more impactful are the components found within the themes of 'reasoning' and 'learning'. Participants appear to be making connections with larger concepts that are not necessarily specific to the context of their classroom. This emerges in components of reasoning such as,

- How all the components fit together (if they do)... research and thoughts
- Understanding what a career in STEM or Tech would be like
- Universal understanding
- Using engineering to solve big issues.

This is expanded upon in the presence of an additional specific theme of 'economic development'. Participants appear to perceive value in their subject for adding to,

- Stronger economy
- Opportunities for Australian miners
- Future / innovation

In addition, participants also express awareness of potentially negative effects of withholding value through theme components of,

- Government suppression of innovation
- Leaders bad at communication

Participants may have awareness of the above opportunities and threats to the future application of their subject, and limited ability to influence outcomes. However, knowledge of the presence of this line of thinking within student participants has implications for teachers.

Value specifically to the student

Components in the theme of 'learning' indicate that participants possess an awareness of learning in the school context and have expectations for its value. An element of frustration, or of being held back is evident in components such as,

- The teacher should lead the students rather than tell them what to do.
- Let students learn from examples rather than a textbook.
- Learning skills without teacher help
- Link knowledge from my brain to be able to come up with new solutions.

The above four components resonate with the aforementioned use of high conviction language as noted in the discussion of Figure 35 above. The notion that teachers *should lead*, or *let students learn*, (italics added) resonates with the reflection that teachers may not be aware of

student conceptualisation of their subjects (as noted in the foreword), leading to dashed expectations of value.

The conviction evident in the above responses is supported using 'I' statements in other responses. These include,

- I value a logical answer.
- Reason I joined.
- I believe that each branch of STEM can help with a logical conclusion.
- What I need to do to achieve goals.
- I am connected/interested in the lesson/topic we are studying.

The use of 'I' in the proposition statement firmly places the perception of value in the individual participant, indicating that 'value' *to the participant* was potentially a strong influence in subject selection. Figure 36 below shows a section of a School A participant response where the connection is clear.

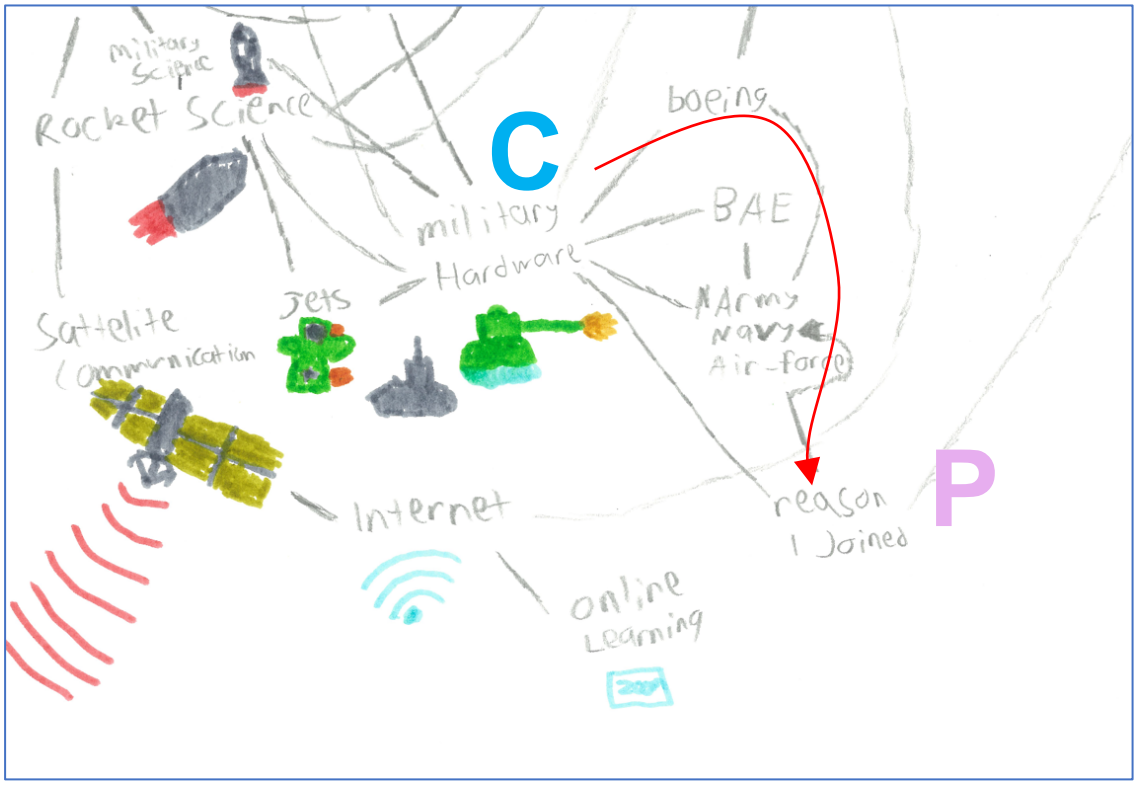


Figure 36

The concept map is superimposed with labels 'C' (concept) and 'P' (proposition) and a red line/arrow indicating relationships between concept and proposition. 'Military hardware' (or military) was identified as a concept for School A in Section 4.2.1. Supported with the use of colour and images, the participant illustrates a relationship formed by established brand names,

Boeing, and BAE, with three major military categories of Army, Navy, and Air Force, to arrive at the proposition of 'reason I joined'.

Table 40 at the beginning of this section indicates more theme components were identified in addition to those discussed in detail above. However, those components speak more directly to the potentially complimentary value propositions between the two subjects. This was prefaced as a distinction between research questions two and three and will be addressed comprehensively in Section 4.4. However, the themes and components discussed in this section indicate that value perception is a factor that participants are aware of with respect to studying their subject. An indication of being held back or restricted (as noted above) and the use of 'I' statements in responses suggests that value plays more than a neutral role in participants' association with, or reasons for selecting the subject. This has implications for teachers which are explored further in the discussion chapter.

To assist the reader, a high-level summary of themes in this sub-section is provided in Table 42 below.

Table 42 Section 4.3.1 High-level Summary

Research Question 2 Section 4.3.1 School A - Themes		
	Technology Participants	**Languages Participants**
Phase 1	**Themes of:** • Value perception • Reasoning • Learning • Economic development	There were no languages participants at School A.
Phase 2	**Themes of:** • Value perception • Reasoning • Learning • Economic development	There were no languages participants at School A.

4.3.2 School B – propositions and themes

Propositions and themes identified in School B concept maps are shown in Table 43 below.

Table 43 School B Propositions and Themes, Phase 1

Theme	School B Propositions Technology students Identified in the Raw Data Phase 1	School B Propositions Language students Identified in the Raw Data Phase 1	Theme
Motivation / Aspiration	making the world a better place helping people Way more to it than designing and practical components	Inspires me to travel around the world for interesting and exciting work.	**Motivation /Aspiration**
		international relations studies interesting discussion in class less misunderstanding and political issues Indonesian is very important for Australia because they share the same space learn another language	**International Relations**
Efficiency / Improvement	better, efficient ways of doing things combining minds to create the best product using tech to design product for the people manual / automation design is whatever you picture it as	important to know language to understand culture to truly understand the country and culture you have to understand the language better understanding of Indonesia itself better understanding of how complicated the English language is understanding other people to know you and your surroundings knowing what is going on deepening understanding of our own language, beauty helps us understand how different our world is understanding of our culture	**Understanding**
Function / Utility	what the client wants many jobs will require concepts learned in DT		
Value Perception	interest in aviation Makes me more creative and makes me calmer person due to it being relaxing to design and letting my mind go anywhere. Informs the world. opportunities galore Unlimited designs in the world, many possibilities. Changing the future Name a problem in today's world that can't be solved by design/STEM. there's always more relates to all subjects engineering is a possible career from DT I always wanted to do Design Tech I rather enjoy building things, hand-working and metal working.	can be used to get a job in Indonesia can impact where you want to live can influence the way someone cooks, eats, speaks to friends and family, their beliefs If the language is known then it makes gaining understanding of the language easier. allows you to meet new people, create connections impacts what you want to do for your occupation international jobs or travelling live in Indonesia jobs requiring Indonesian speakers better qualified looks good on resume work collaboratively with others helps with adapting, making you a better person is a life skill coping with change seeing things differently	**Value Perception**

Theme	School B Propositions Technology students Identified in the Raw Data Phase 1	School B Propositions Language students Identified in the Raw Data Phase 1	Theme
		gives you more versatility allows you to understand lets me connect with more people being able to express ideas to people not from your country/home helped me stay connected to year 8, as I learned Italian at my old school	
Making / Creating	physical skills and techniques I'm rather good at DT and creative subjects solving problems through designs using creativity using STEM technologies making things in the workshop allows me to be more open with my own ideas learn how to use new techniques allows me to work with my hands > I can use new tools. Interest in engineering and building things.	key reason why I chose the subject interest in improving myself interest in key ideas	**Choice**
Frustration	I thought this subject we would have more hands-on tasks. I thought this subject would be mainly design and the design process, but it was mostly research assignments. Not much creativity in class. Two very different ends of the spectrum, what I thought prior to the course. COVID-19 stopped most of our practical work. Can't use most of the machines, y11 & 12 only. Running low / don't have the materials.	close to my heart shapes the way you think Non materialised reward for learning about another country. Fascination with French. See, understand and admire France in a different way. To rid ignorance Opens you up to other cultures. love their flag love their city love of learning After I joined, I realised so many artists were French, and I love painting. Because I am a creative person, taking an interest in writing, painting, and language learning. Gave me ideas for painting.	**Passion**
Choice	Never enjoyed languages or music as electives. I wish this subject could be like I thought instead of lots of theory and listening. I would not choose this subject again. my family has had a history of people …working…engineering tasks or jobs		
Learning	brain break between other more fact-based subjects wanting to build on skills and discover new ones teaching the younger generation		
Reasoning	What is the reason for what you have built?	benefits your learning abilities fun to learn other languages beneficial to the brain, learning	**Learning**

Theme	School B Propositions Technology students Identified in the Raw Data Phase 1	School B Propositions Language students Identified in the Raw Data Phase 1	Theme
This cell is left intentionally blank.		another language able to recognise the difference in English and French easy to learn makes me willing to learn makes it fun to learn improves memory skills improves intelligence across different subjects being able to learn about culture makes links between everyday life & language which is why it's easy to learn makes learning feel like self-help personally makes me more creative makes me more organised in thought helped my communication in English helps communication in English & learn, or rather remember more words in existing vocab due to French using both sides of the brain requires knowing how to relate to things problem solving Easier to learn when you already speak another language.	
		ATAR points have family in France the basics of the subject, enough to talk to French people school & higher ATAR improved speaking skills in both English and Indonesian communicate with different people with a different language learning how 2 communicate effectively can only come with travel	**Function / Utility**
		sport, family, friends, food culture shared with other countries understanding similarities and differences to Australia old artefacts that have shaped the culture instead of just speaking & stuff I wanted to know where it came from kinda ties into history to experience culture you must travel	**Culture**
		broaden my vocab because it is the oldest living language gives one the ability to participate in the most important parts of language French is more than a language easiest to relate because it's a European language I took an interest in French	**Language**

School B Phase 1 concept maps produced a range of propositions. As for School A, the quantity is described as a range because proposition statements varied from single or multi-word representations to complete sentences. Table 43 above is divided into technology and languages participants.

Propositions were identifiable in accordance with the methodology described in Chapter 3 and some variation was evident in the way propositions were recorded. The variation did not create a hindrance to proposition creation, and in some cases displayed further diversity in the representation of concepts, relationships, and propositions. Figure 37 below demonstrates a sample of a technology participant response where propositions are stated separately to a diagrammatic illustration. This is similar to the example in the previous section (Figure 15) and adds support to the reliability of the method, given that participants were located in different schools. Figure 37 is superimposed with labels ‘P’ (proposition) and ‘C’ (concepts) and red lines/arrows indicating relationships between connected elements. ‘Science’ and ‘Design’ were identified as concepts in School B responses. The red lines indicate that the participant could identify elements that were related to the concepts, yet the propositions were stated separately. In the case of ‘design’, the elements of ‘creativity’, ‘décor’, ‘outside the box’, ‘advertisement’, and ‘popularity’, were presented as things to be considered, adopted, or accepted in relationship to the concept (design). Stated separately, although clearly referenced as a proposition for ‘design’, the participant offers a proposition from a high conviction, personal perspective.

> “Design is whatever <u>you</u> picture it as.”

Emphasis is added by the participant by underlining the word ‘you’ in the proposition.

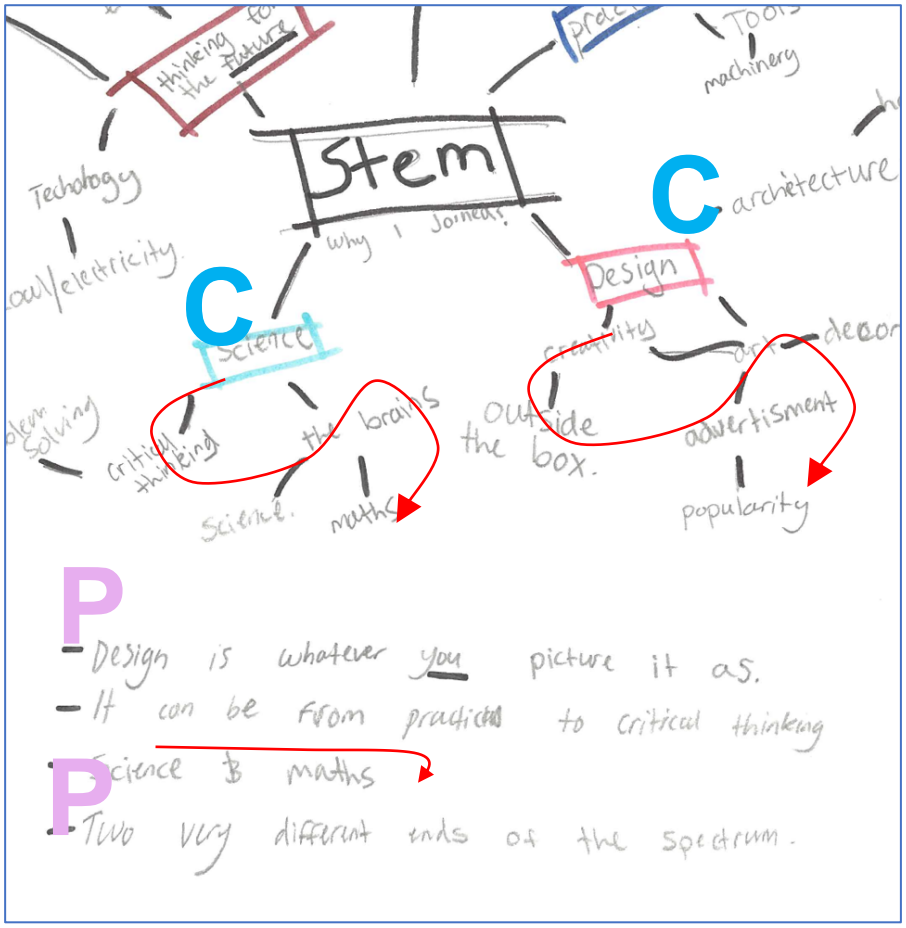


Figure 37

In contrast, Figure 38 below demonstrates an extract of a languages participant response with simpler morphology. Figure 38 is superimposed with labels ‘C’ (concept) and ‘P’ (proposition) and a curved red line/arrow indicating relationships between connected elements. ‘Subject’ (or subject at school) was identified as a concept in School B responses. In this case, the pathway from concept to proposition is shorter and more direct. The participant clearly communicated a value proposition for studying French. The subject itself ‘which assists in’ ‘ballet and dance’ is a ‘key reason why I chose the subject’. For this participant, the consideration of the performing arts was the main component to be accepted, adopted, or encountered.

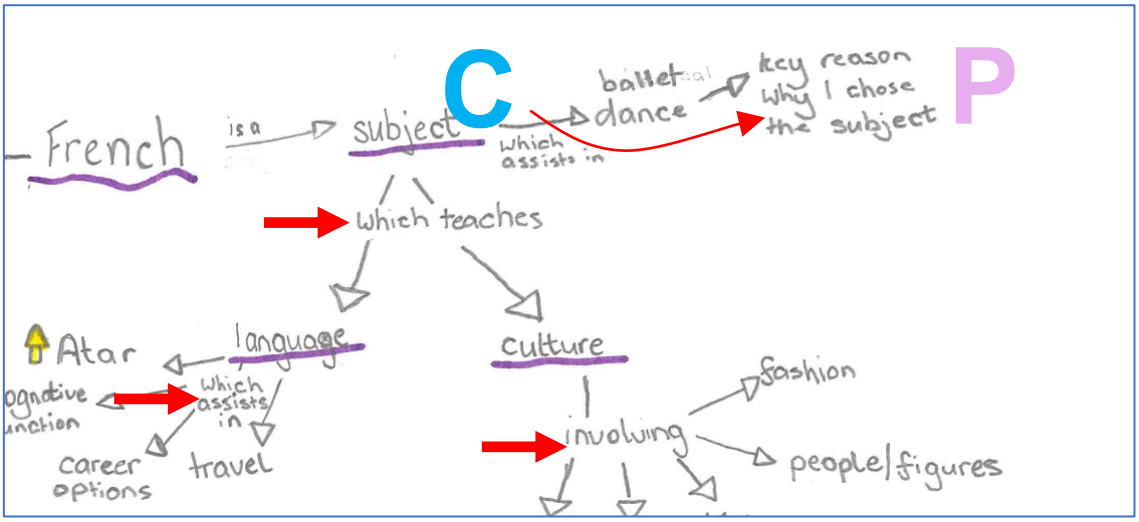


Figure 38

Figure 38 is also superimposed with three solid red arrows which provide insight as to how the participant perceives relationships and connections within the subject. Three points are noted.

- Which teaches
- Which assists in
- Involving

These elements communicate an awareness of utility within the subject. The participant is aware that,

- The subject does something: it teaches.
- What the subject 'does'. Provides benefit to the participant: it assists in facilitating a key motivation for the participant.
- The subject is made of complementary components working together: involving.

Therefore, whilst the representation on the concept map is simpler, it does not lack depth of insight in the overall response.

Both technology and languages participants produced a volume of propositions that could be arranged into themes. A summary of themes is provided in Table 44 below.

Table 44 Proposition Themes, School B, Phase 1, Technology & Languages

Proposition Themes Technology students School B Phase 1	Proposition Themes Languages students School B Phase 1
Motivation / Aspiration **Value Perception** **Learning** **Function / Utility** **Choice**	**Motivation /Aspiration** **Value Perception** **Learning** **Function / Utility** **Choice**
Frustration **Efficiency / Improvement** **Making / Creating** **Reasoning**	**International Relations** **Understanding** **Passion** **Culture** **Language**

Table 44 indicates a similar number of themes identifiable in technology and languages participant responses. Noteworthy is that five of the themes are shared between the two cohorts, with other themes appearing as more 'subject specific'. Since the research question addressed in this section (RQ2) investigates value perception and motivation, the themes of first interest are,

- value perception
- choice
- motivation / aspiration

Other themes present will be addressed further in the discussion chapter. However, the theme of 'frustration' will also be addressed in this section as it pertains to the *lack* of value, and potentially acts as a de-motivating factor. The theme of 'learning' will also be addressed briefly as it resonates with the way in which learning appeared in participant conceptualisation in Section 4.2. Whilst not specifically a 'value perception' theme, participants make noteworthy reflections on its importance.

Technology participants produced propositions in the theme of value perception through a combination of reflections on self, and of the wider world. There was both a personal nature to the responses as well as those relating more to wider benefits. Personal responses included language such as,

- makes me more creative and makes me calmer person due to it being relaxing and letting my mind go anywhere.
- I always wanted to do Design and Tech
- I rather enjoy building things, hand-working and metal working.

Wider reaching responses included theme components of,

- Informs the world.
- Opportunities galore
- Unlimited designs in the world, many possibilities
- Changing the future
- There's always more.

Taken together, there is a latent energy in the responses for this cohort that implies a desire for action. In one case, the response could be considered a challenge put forth to the 'world' for the subject of 'technology' to meet. Recorded as a complete sentence, it states,

- Name a problem in today's world that can't be solved by design/STEM.

This not only suggests an energy in the response, but also a high level of conviction that the subject can deliver on this challenge.

Within the same responses, technology participants also produced propositions that could be identified thematically as 'frustration'. There is a sense that despite the subject holding much potential for individuals and the wider world, participants expressed that they were subjected to limitations which would stifle the potential. The use of 'I' and 'our' language in the responses indicates reflection on a personal level with a direct impact on individual value perception. Propositions include,

- I thought this subject we would have more hands-on tasks.
- I thought this subject would be mainly design and the design process, but it was mainly research assignments.
- Two very different ends of the spectrum, what I thought prior to the course.
- COVID-19 stopped most of our practical work.

It is possible that school closures during the COVID-19 pandemic did create insurmountable barriers to practical class activities. However, the other propositions presented suggest that the limitations extended beyond the lockdown periods. It is also likely that this frustration could be exacerbated by its coexistence with the theme of 'motivation / aspiration', as the participants desire to reach for greater outcomes and yet are limited in their opportunities to do so. School closures notwithstanding, the juxtaposition of energetic value propositions and the perception of limitations creates a tension that has implications for teachers. Participants communicated a high expectation for the subject with a clear conceptualisation of its potential. Yet, as noted in Section 4.1 Foreword, this could be an example of a mismatch in perception of student / teacher conceptualisation resulting in hopes of a value proposition dashed.

Languages participants produced propositions themed as value perception on a different basis to technology participants. Propositions referenced employment opportunities, which has a

direct value impact on the individual. However other propositions were focussed less on impacting the world and more on interacting or integrating *with* the world. A shift in motivation is evident from what participants could do 'to' the world and more towards how they can be better people 'within' the world. Propositions indicating such motivation include,

- Can impact where you want to live.
- Can influence the way someone cooks, eats, speaks to friends and family, their beliefs.
- Allows you to meet new people, create connections.
- Live in Indonesia.
- Work collaboratively with others.
- Coping with change.
- Lets me connect with more people.
- Helps with adapting, making you a better person.

Whilst these propositions do impact the individual, there is an awareness of others on an interpersonal level. Benefit is not achieved through creating a product that makes something better, but by being a better person within another culture or context. It is not suggested that this is either correct or incorrect. Neither can the above propositions be interpreted to be typical of languages participants in any context, or that they are purely other person centred. Languages participants also expressed propositions themed as 'motivation / aspiration' that are more focussed towards benefit to the individual in statements such as,

- Inspires me to travel around the world for interesting and exciting work.

However, there are implications for teachers in these data for the way in which the subjects are portrayed to current and prospective students. The data support the notion that students do perceive value in their subjects well beyond what may be considered as curriculum content.

With respect to the theme of 'choice', languages participants presented several propositions which were identified specifically within that theme. However, they were fewer in number than those for 'value perception'. They included,

- Key reason why I chose the subject
- Interest in improving myself
- Interest in key ideas

The notion of participants making active choices appeared evident in these propositions as recorded on concept maps. However, an additional theme appeared which complements 'choice'. Languages participants offered propositions that communicated a deeper, more emotional response, which, when considered in the context of 'value perception' and 'choice', was themed as 'passion'. It is recognised that being passionate, or having a passionate view of something is subjective with potential for wide variation. Examination of the propositions revealed language including,

- Close to my heart
- To rid of ignorance
- After I joined, I realised so many artists were French, and I love painting.
- See, understand, and admire France in a different way.
- Love their city
- Love their flag
- Love of learning

It is not suggested that languages participants in any given context would respond in this way. It is also possible that this cohort, in this instance, was particularly cohesive and engaged in the subject. That is, these participants came from what might be colloquially named as a 'good class'. Yet the presence of these propositions indicates that there are students who will engage on this level, bringing an intrinsic motivation based on deeply felt perceptions about the subject.

The theme of 'learning' also featured prominently for languages participants. Responses indicated strong personal reflections through repeated use of words such as 'me', 'my', and 'your'. Whilst not themed as 'choice', the language in the propositions suggests an ownership or agency with respect to their learning. Or, that a sense of agency could influence choice. Propositions spoke mainly to benefits and abilities gained from learning languages, resulting in personal growth for participants. Learning appears as a concept that participants are not subjected to, but rather one that they are a part of, and grow with. Moreover, that they consider this to be valuable. A selection of such propositions found include,

- Benefits your learning abilities.
- Makes me willing to learn.
- Makes learning feel like self-help.
- Makes me more organised in thought.
- Helped my communication in English.

There was specific reference to learning another language through propositions such as,

- Fun to learn other languages.
- Makes links between everyday life & language which is why it's easy to learn.

However, the components of language learning such as reading, writing, spelling, and grammar, which might typically be associated with language *learning*, were notably absent in the responses.

Propositions that were less expected included,

- Beneficial to the brain, learning another language.
- Improves memory skills.
- Improves intelligence across other subjects.

Propositions such as these support the abovementioned observation that ‘learning’ for these participants was more about something that they were involved with, rather than exposed or subjected to. A knowledge of this kind of perception has implications for teachers which will be addressed further in the discussion chapter.

In stark contrast, technology participants offered propositions of ‘choice’ that were framed in the negative. Propositions include,

- Never enjoyed languages or music as electives.
- I wish this subject could be like I thought instead of lots of theory and listening.
- I would not choose this subject again.

On face value, these propositions offer a negative view of ‘technology’ as a subject to undertake. This presents a conundrum because in the findings outlined earlier in the section, technology participants offered numerous value propositions for both personal and wider positive impact. Moreover, that these perceptions of value might be considered as motivators to select the subject. This resonates again with the mismatch of conceptualisation as discussed in the foreword to this chapter. Students had a concept doing ‘X’ but experienced ‘Y’. The propositions of choice are extrapolated (again, in the negative sense) in the theme of ‘frustration’. These include,

- I thought this subject we would have more hands-on tasks.
- I thought this subject would be mainly design and the design process, but it was mostly research assignments.
- Two very different ends of the spectrum, what I thought prior to the course.
- Not much creativity in class.

The theme of ‘learning’ also appears for technology participants, although to a lesser degree than for ‘value perception’ and ‘frustration’. A notable distinction is made in the proposition of,

- Brain break between other more fact-based subjects.

The implication that technology subjects (in this case Design and Technology) are less fact-based presents a point of consideration for teachers. It is possible that the participant is referring more to the creative potential within Design and Technology and regarding it with higher value than learning facts or learning about facts. More pertinent in this case is that the participant perceives the lack of something (learning facts) as valuable, whilst still pursuing learning within the subject. That is, learning is important, provided it is the right kind of learning.

Taken together, the themes of value perception, choice, and frustration for technology participants also indicate a sense of energy with respect to value perception, yet with a mixture of positive and negative motivations. Similarly, as for languages participants, this does not

suggest that technology students in any given context would respond in this manner. Rather, these findings add support to the notion that students can bring a strong *expectation* of value to the subject based on their overall conceptualisation and *perception* of value. Where this perception begins in the lives of participants will be considered in the discussion chapter.

Phase 2 Concept Maps

School B Phase 2 concept maps produced propositions with some notable differences to Phase 1 concept maps. They are presented in Table 45 below.

Table 45 School B Propositions, Phase 2, Technology & Languages

Theme	School B Propositions Technology students Identified in the Raw Data Phase 2	School B Propositions Languages students Identified in the Raw Data Phase 2	Theme
Value Perception	Improve the way we live. Improve divergent and convergent thinking. Many people gain enjoyment out of learning new things. (Positive wellbeing) this is a must for me because if I am not enjoying the subjects, it isn't good for me. Overall, it is a good subject for life. Technology has many new things for people to learn. Languages can be helpful. Benefits people around you. Positive effect on your wellbeing. There is a fun social aspect to design, that's why I do the subject. Fun Beneficial Lots of possibilities Skills can be applied to other subjects and out of school. Can be more creative in this subject than in others. Helps de-stress. Allows me to be more creative.	I want to do Indo at uni. Overseas travelling for my job in the future. 2020 is hard, so a break is fun. Improves skills. If we had more leaders who knew Indonesian, Indo-Australian relations could be better. Gives you different opportunities that could be life changing. Opportunity to meet more people. Getting to know problems in the world and helping make things better. Speaking multiple languages can boost confidence in public speaking. Useful in performing arts. The course can be tiresome and content heavy... ultimately it is beneficial to our overall understanding of all the components of French. Everything we learn in French when it concerns the language itself, is important... ...unlike other subjects all the knowledge we obtain	**Value Perception**

Theme	School B Propositions Technology students Identified in the Raw Data Phase 2	School B Propositions Languages students Identified in the Raw Data Phase 2	Theme
	This cell is left intentionally blank.	is important with very little exceptions. Improving little by little. Because French is a language you can do anything with it. A lot of things we do is mainly things like history and stuff, which is great, but I would an equal focus on creative outlets in this language. A lot of things we do is mainly things like history and stuff, which is great, but I would an equal focus on creative outlets in this language. What I want. Fun job opportunities where an open mindset and creativity are needed for success.	**Value Perception**
Understanding	Increase understanding between us (society) and the environment (materials, consumerism, ethics, habits & change, equality). Deepen understanding of others needs and problems, think beyond ourselves. To understand opportunities in the world to design. Relate to their point of view. Understanding other people. Understanding new concepts within technology. Forces different perspectives to understand design greater. Helping everyone with it. Understanding of why something is the way it is better understanding of how the world is changing (emerging tech, wearable tech). Deepens understanding of the world and technology.	Helps us see the world differently. Language barriers can lead to a lack of understanding. Makes it easier to know how others live. understanding - other cultures understanding - how our world works Allows you to understand and learn a new different part of the world. Open up a new way of thinking. Looking at the world in a different way. Understanding of different cultures helps boost connections to the country, culture, language. Understanding French grammar and literacy helps with understanding our English language and history. Better understanding of the world around you and importance of language in culture. Understanding their culture gives you more experience, more ability to enjoy it.	**Understanding**
Connection	Technology is a great way of connecting with other people. Through tech we can design and create new things that bring people closer. Having connection to things you build.	Connects me to the world. Improve relationship with the world around you and with other people. French links to other English and other languages which makes it so much easier. Makes you able to link between people. New friendships and relationships with others.	**Connection**

Theme	School B Propositions Technology students Identified in the Raw Data Phase 2	School B Propositions Languages students Identified in the Raw Data Phase 2	Theme
		Helps subjects like science. Helps subjects like English. Engaging the person.	
	This cell is left intentionally blank.	Is important with very little exceptions. Improving little by little. Because French is a language you can do anything with it. A lot of things we do is mainly things like history and stuff, which is great, but I would an equal focus on creative outlets in this language. A lot of things we do is mainly things like history and stuff, which is great, but I would an equal focus on creative outlets in this language. What I want. Fun job opportunities where an open mindset and creativity are needed for success.	**Value Perception**
Understanding	Increase understanding between us (society) and the environment (materials, consumerism, ethics, habits & change, equality). Deepen understanding of others needs and problems, think beyond ourselves. To understand opportunities in the world to design. Relate to their point of view. Understanding other people. Understanding new concepts within technology. Forces different perspectives to understand design greater. Helping everyone with it. Understanding of why something is the way it is better understanding of how the world is changing (emerging tech, wearable tech). Deepens understanding of the world and technology.	Helps us see the world differently. Language barriers can lead to a lack of understanding. Makes it easier to know how others live. understanding - other cultures understanding - how our world works Allows you to understand and learn a new different part of the world. Open up a new way of thinking. Looking at the world in a different way. Understanding of different cultures helps boost connections to the country, culture, language. Understanding French grammar and literacy helps with understanding our English language and history. Better understanding of the world around you and importance of language in culture. Understanding their culture gives you more experience, more ability to enjoy it.	**Understanding**

Theme	School B Propositions Technology students Identified in the Raw Data Phase 2	School B Propositions Languages students Identified in the Raw Data Phase 2	Theme
Connection	Technology is a great way of connecting with other people. Through tech we can design and create new things that bring people closer. Having connection to things you build.	Connects me to the world. Improve relationship with the world around you and with other people. French links to other English and other languages which makes it so much easier. Makes you able to link between people. New friendships and relationships with others. Helps subjects like science. Helps subjects like English. Engaging the person.	**Connection**
Learning	Willingness to learn, and then to share. Constantly learning more and becoming better at previous skills. Gives you different perspectives which enhance learning abilities for many other things. Makes it easier to learn. Uses both sides of the brain. Fun to learn. With practise and greater understanding, intelligence in the subject grows greater and greater. Can make you think about things differently, helping gain intelligence in other scenarios. Learn and understand life skills about design and tech. Helps me to understand more about the subject / topic. I like to learn about new things that can help me in life. Learn how to use machinery and different tools that can be handy in life. Easy to learn. Hands-on learning. Theory, learning about design, emerging and current technology.	Capability - to learn languages. Improves your brain, mindset. Uses a different part of your brain to make you smarter. Enabling you to learn different words as well as make connections between French and English words. Thinking creative in French in how you do tasks. opens new way of thinking. Learning, different skills, problem solving Learning more languages. Learning about grammar and reading etc. is important for our speaking abilities... Helping us communicate better in France, and brain growth. Learning new skills in French. I think games are the best way to learn. The idea of layering my skills in this language is how I think of this subject. Goes into the history) but not censoring anything as some teachers do. To learn new skills. Solving is a major part of Indo because it is how we learn (from mistakes) and improve our skill. Another key component because by asking questions we improve our skill. Everything leads back to improving or learning skills. Brain is active because of use of memory in learning a language leading to greater picture in problem solving. You improve your understanding of the culture and the language through these subjects.	**Learning**

Theme	School B Propositions Technology students Identified in the Raw Data Phase 2	School B Propositions Languages students Identified in the Raw Data Phase 2	Theme
Design / Make	Think of it then make it.	I am not sure of being able to solve the problem	**Design / Make**
Reasoning	Understanding people's reasoning for doing something that way. Balance of power and influence due to use of things. Different people have different perspectives within design that can have many different outcomes. People often think the course is stereotyped to certain job opportunities. Helps you look for reasoning in the world's designs.	Using logic to unfold the language and how it works. Using multiple languages and angles when solving and questioning. How do we bridge one language barrier? Why do French people think differently? What aspects of the culture are different? How are we different? Think in a different way. Solve problems. Making sense. Logic to ask why.	**Reasoning**
Vocation / technology discipline	jobs (traditional trades, electrician, carpentry, plumbing) engineer, architect, landscaper	Learning about another culture, food country traditions places. By learning about culture we gain a deeper appreciation of it. Every component counts, whether it is how to shop or how to book for a youth hotel. Learning about culture helps you understand life in France more. French, the language of romantics. Most of French culture is a mix of international beliefs. Major multiculturalism. The French', romantics, always fancy, rich. Learning about indo culture whilst learning the language. Curiosity and interest in language and culture. French philosophy is a lot different than Western philosophy, makes you ask about life in a different way than you would without. Through learning new phrases you can understand the culture. Helps to learn about culture.	**Culture**
This cell is left intentionally blank.	Different people perceive hands-on learning and typical in class learning differently, Often in-class learning can be more fruitful but less enjoyable. Half of English and French words are the same. I would reconceptualise languages in the sense that I would want to learn how to be creative in this language. I'd probably want to learn how to do things like poetry/creative writing like we do in English class.	**Insight**	

Theme	School B Propositions Technology students Identified in the Raw Data Phase 2	School B Propositions Languages students Identified in the Raw Data Phase 2	Theme
	Makes you look at life in a different way through other people's perspectives. France is much more eco-friendly than Australia which makes you think more about how Australia can improve and WHY. French has a different mindset. Makes your acceptance to other cultures better. Listening to others and take it in. Seeing things in a different way. Helps to learn about yourself.		
This cell is left intentionally blank.	Going into things like how to change words into written format would be a bit better and useful. Improving in this language is also something that I consider when going into this subject. Overall improving my fluency in Indo. Pursuit to build on and improve speaking , listening and understanding. Using language skills to best translate phrases to create an effective meaning that is consistent across languages. Re-arraning word order in translation to form an effective and correct sentence. Learning to speak, understand patterns. Some things cannot be solved like irregular endings, verbs, grammar. Improve the way you can manufacture language. English has more fluidity because I'm more familiar with the words. You basically manufacture your own language type. Not as creative in English, more in French.	**Language**	

Phase 2 propositions were arranged into themes as for Phase 1 and are summarised in Table 46 below.

Table 46 School B, Proposition Themes, School B, Phase 2, Technology & Languages

Proposition Themes Technology students School B Phase 2	Proposition Themes Languages students School B Phase 2
Value Perception **Understanding** **Connection** **Learning** **Design / Make** **Reasoning**	**Value Perception** **Understanding** **Connection** **Learning** **Design / Make** **Reasoning**
Vocation / Technology Discipline	**Culture** **Insight** **Language**

In Phase 2 there was greater similarity in themes between technology and languages participants. Whilst languages participants produced a greater volume of propositions within those themes, Phase 2 data did not introduce new themes. However, Phase 2 data indicated the emergence of a cross-over of propositions mostly in technology participants, and to a lesser extent in languages participants.

For technology participants, there was a subtle shift in the propositions offered in the theme of 'value perception'. In Phase 1, propositions of value carried a functional or utilitarian characteristic in that technology could improve, make changes, and impact the future. Examples include,

- Informs the world
- Changing the future
- Engineering is a possible career from DT

In Phase 2, the shift becomes evident in propositions including,

- Improve divergent and convergent thinking.
- Benefits people around you.
- Overall, it is a good subject for life.
- (Positive wellbeing) this is a must for me because if I am not enjoying the subjects, it isn't good for me.
- Helps de-stress.

These propositions are developed in a further theme which was present for languages participants in Phase 1, but not for technology participants: the theme of 'understanding'. Technology participants began to reflect more deeply on implications for people, both as individuals and members of society. A greater understanding of perspective is also present.

Languages participants appeared to consolidate or reiterate their responses with increased volume. In addition, the theme of 'reasoning' surfaced which was not present in Phase 1. This supports an indication that languages participants became aware of factors influencing technology participants, and that they considered them enough to record them. The emergence of a potential interleaving of conceptualisation and value perception between the two cohorts reflects the nature of the second underlying research question in this study (RQ3). This is referenced in the distinction between research questions two and three in Section 4.3 and is therefore not discussed further in this section but explored comprehensively in Section 4.4.

Follow-up interviews

School B Phase 2 propositions arising from follow-up interviews did not produce new themes for consideration (see also Appendix J). Interviews confirmed or consolidated findings presented in concept maps and were recorded in longer sentences due to the interview format. Given the size of the table resulting from the recording of propositions and themes, it is provided in Appendix L for reference. The themes identified are summarised in Table 47 below.

Table 47 Proposition Themes, School B, Phase 1&2, Technology & Languages

Proposition Themes Technology and Languages students As recorded in raw follow-up interview data	
Phase 1	**Phase 2**
Value Perception	**Value Perception**
Frustration	**Learning**
Culture	**Insight**
Connection	**Connection**
Learning	**Learning**
Insight	**Insight**
Design / Make	
Motivation / Aspiration	

Due to scheduling constraints, the summary of themes is based on interviews conducted in groups combining both technology and languages participants. Phase 2 follow-up interviews resulted in fewer propositions and themes than Phase 1. This is likely due to an indication of data saturation as participants appeared to be physically exhausted by the data collection process with fewer comments to offer.

The research question addressed in this section examines the extent to which value propositions offered by technology and languages subjects motivate students to study those subjects. School B propositions emerging from concept map data illustrated that participants were able to conceptualise their subjects and identify relationships that led to the development

of propositions about their respective subjects. Not all propositions and themes spoke directly to value perception and motivation. However, the propositions listed within the themes of ‘value perception’, ‘motivation / aspiration’’, and ‘choice’ produced responses that were personal, and in some cases deeply emotive. In the case of technology participants, value was also stated in the positive (expectations were met) and the negative (expectations were not met). The range of emotive responses was therefore also accordingly wide. Both technology and languages participants were able to separate the impact that value from each subject area bestows on individuals and wider society. The data suggest that whilst value perception is not an exclusive theme that contributes to motivation to select the subject, it is a theme that participants are able to communicate clearly and with conviction. That students have this awareness has implications for teachers as they plan for and execute the delivery of subjects, which will be addressed further in the discussion chapter.

To assist the reader, a high-level summary of findings in this sub-section is provided in Table 48 below.

Table 48 Section 4.3.2 High-level Summary

Research Question 2 Section 4.3.2 School B - Themes		
	Technology Participants	**Languages Participants**
Phase 1	**Themes of:** • Motivation / Aspiration • Efficiency / improvement • Function / utility • Value perception • Making / creating • Frustration (negative value) • Choice • Learning • Reasoning	**Themes of:** • Motivation / Aspiration • International Relations • Understanding • Value Perception • Choice • Passion • Learning • Function / Utility • Culture • Language
Phase 2	**Themes of:** • Value perception • Understanding • Connection • Learning	**Themes of:** • Connection • Reasoning • Insight

4.3.3 School C – propositions and themes

School C Phase 1 concept maps produced a range of propositions. As for School A and School B, the quantity is described as a range because proposition statements varied from single or multi-word representations to complete sentences. There are fewer technology responses in the data for School C as there were only two technology participants. Propositions were identifiable in accordance with the methodology described in Chapter 3 and some variation was evident in the way propositions were recorded. The variation was consistent with data recorded for Schools A and B. Due to lower participant numbers than School B, it is possible to present School C propositions and themes in Table 49 below, divided into technology and languages participants.

Table 49 School C Propositions and Themes, Phase 1, Technology & Languages

Theme	School C Propositions Identified in the Raw Data Technology Students Phase 1	School C Propositions Identified in the Raw Data Languages Students Phase 1	Theme
Motivation / Aspiration	Dreams (preferred futures) Inspiration Future Be the future. Change the world (even if only a little) Change someone's life	To value different activities, foods, (animals?) To value different ways people use their language. So I can interact with other people in the world without having difficulties understanding. To connect different programs, jobs, opportunities. Helps you understand your own situation and how well-off you are. Makes connections that monolinguists would not make. Open up a new world. Previous success. Future travel. Speaking (new language) regularly. Enjoyment, learning about other cultures, countries. Benefit from being even partially bilingual Be able to survive and cope in a Francophile country. Communicate with a more diverse range of people. Apply skills in learning French to other subjects. Still always something new. Constant feeling of progress. Rewarding but occasionally overwhelming. Opens up more future options. Requirement for a scholarship, career.	**Value Perception**
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Theme	School C Propositions Identified in the Raw Data Technology Students Phase 1	School C Propositions Identified in the Raw Data Languages Students Phase 1	Theme
This cell is left intentionally blank.	This cell is left intentionally blank.	Doesn't mean anything in English, but it does in French. Can help you accept your own situation. Can lead you NOT to accept others' hardships as 'just life'. Understand people's motives, opinions, life experiences. Learning doesn't happen overnight or from just memorising. It comes from understanding, not rote learning…shared bonds.	**Reasoning**
This cell is left intentionally blank.	This cell is left intentionally blank.		
This cell is left intentionally blank.	This cell is left intentionally blank	To help others to understand different individuals, translate. Learn through consequences and real-life situations. Teaching others, helping others my future. By giving more people the opportunity to learn and help others around the world. I want to help people around the world. Desire to help others. Preferred future…living in Europe. We aren't everything. We are less important than we think we are = humanity.	**Motivation / Aspiration**
		Appreciation of new cultures. Seeing how others live their life is interesting. Cultural differences are astounding.	**Culture**
		Appreciation for how communication works. Understand others and the world better. Expressing myself in a new language allows me to express myself. Speaking with locals, asking where places are.	**Communication**

Figure 39 below presents a section of a School C languages participant concept map. This example is provided to demonstrate consistency between research sites, as this interpretation

of the concept map procedure is similar to Figure 38 in the preceding Section 4.3.2. It presents a simple structure, with minimal use of colour and imagery.

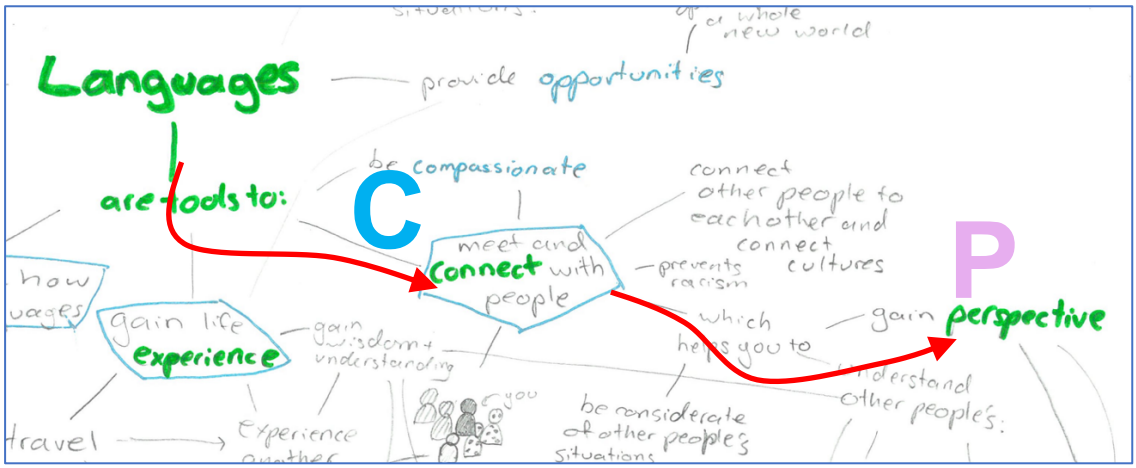


Figure 39

Figure 39 is superimposed with labels ‘C’ (concept) and ‘P’ (proposition), with red lines/arrows indicating the flow of connected elements. The structure is simple and provides a direct path from the main concept through to the final proposition despite the complexity of the overall morphology of the concept map. ‘Connect’ (connection) was identified as a concept for School C. The participant relates the concept of meeting and connecting with people (whilst preventing racism), ‘which helps you’, to ‘gain perspective’. The participant has written the word perspective in green, presumably to add emphasis. Several other elements radiate from the concept of connection and are related to the notion of connecting. ‘Gaining perspective’ in this section of the concept map was identified as the proposition as it offers a thing to be considered, adopted, or accepted as an end point from this line of thought.

By contrast, Figure 40 below presents a section of a School C languages participant concept map which uses minimal words and extensive use of colour and images.

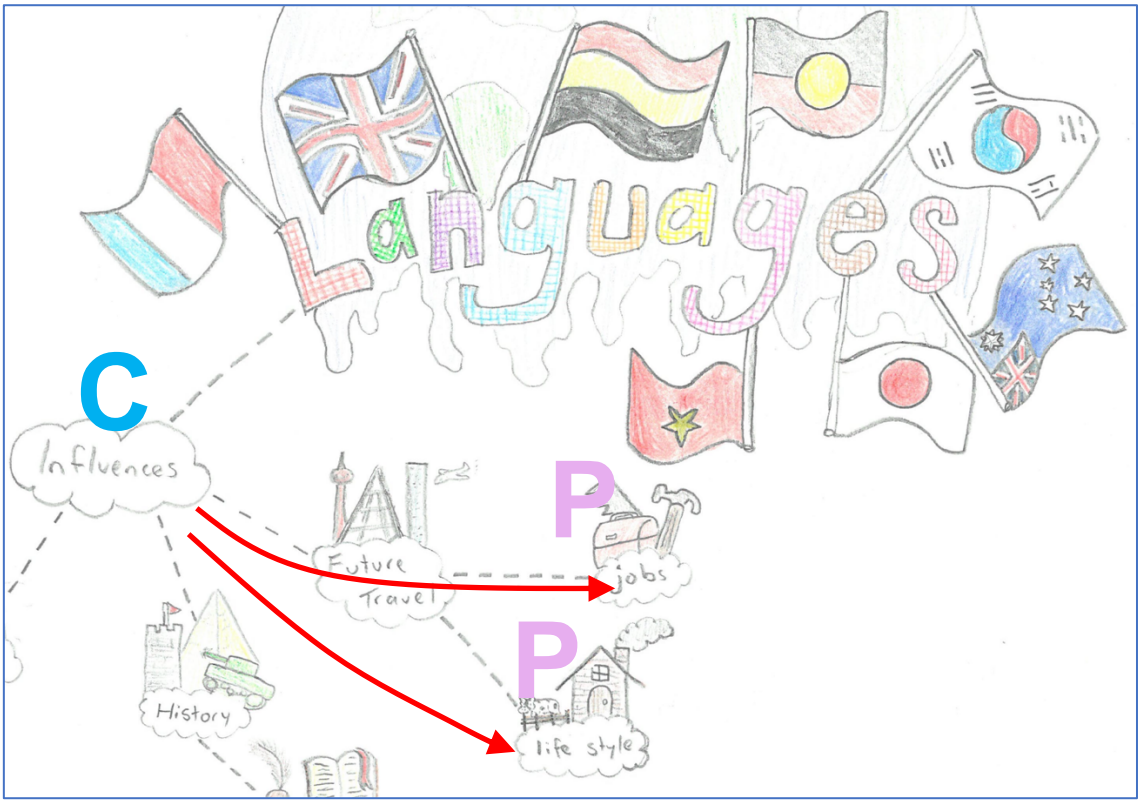


Figure 40

Figure 40 is superimposed with labels ‘C’ (concept) and ‘P’ (proposition) with red lines/arrows indicating the relationship between connected elements. The pathway from concept to proposition is simple and direct, similar to Figure 39. ‘Influences’ was identified as a concept for School C. The participant uses ‘future travel’ to construct a relationship to arrive at propositions of ‘jobs’ and ‘lifestyle’. The study of languages exposes students to influence, which through future travel could present ‘jobs’ and ‘lifestyle’ as a thing to be considered, adopted, or accepted. ‘Future travel’ sits as a relationship between the concept and the proposition as an enabling factor. This is neither correct nor incorrect. Figures 39 and 40 are provided here to illustrate that participants drew similar conclusions with respect to conceptualisation and proposition with varied expression within the boundaries of the instructions provided in the study.

School C Phase 1 concept maps produced fewer, though similar themes to Schools A and B. They include,

- Value perception
- Reasoning
- Motivation / Aspiration
- Culture
- Communication

‘Motivation / Aspiration’ was the only theme identifiable from technology participants’ concept maps. This is likely due to the lower number of technology participants in the cohort (only two). Since value perception and motivation are being investigated in the research question addressed in this section, the themes identified of ‘value perception’ and ‘motivation / aspiration’ are of first interest. Other themes present will be addressed further in the discussion chapter.

Technology participants did not present propositions that were identified specifically with ‘value perception’. The theme of ‘motivation / aspiration’ was present through propositions including,

- Dreams (preferred futures)
- Inspiration
- Be the future.
- Change the world (even if only a little)
- Change someone’s life.

Despite the above propositions not being themed as value perception specifically, it is possible that participants find these propositions to be valuable by implication. That would require the assumption that, for example, ‘changing the world’ was intended to imply positive change and that this was held as valuable by the participant. Likewise, that the opportunity to ‘change someone’s life’ is assumed to effect positive change, and that this was a motivating factor for the participant to study the subject. However, these assumptions provide little support to suggest that the propositions offered could be enough to influence students to study technology subjects. To explore these assumptions further would also have required further access to participants which was not possible within the scope of the study. Nor was this line of enquiry central to the research questions.

In contrast, languages participants provided propositions that were more readily themed as ‘value perception’; consistent with Schools A and B. Participants also specifically used the word ‘value’ in several responses. Propositions included,

- To value different activities, foods (animals?)
- To value different ways people use language.
- To connect different programs, jobs, opportunities.
- Open up a new world.
- Be able to survive and cope in a Francophile country.
- Helps you understand your own situation and how well-off you are.
- Requirement for a scholarship, career.

The above propositions indicate an awareness of personal and wider impacts of studying languages. Participants show evidence that they consider their current and future circumstances by considering ‘how well-off they are’ currently and what ‘future’ opportunities

exist for them as a result of studying languages. The potential benefits appear to be present and tangible.

Languages participants also make strong references to motivation for the purposes of effecting positive change on other people. There is a sense of altruism in propositions offered, including,

- Teaching others, helping others
- By giving more people the opportunity to learn and help others around the world.
- Desire to help others.
- We aren't everything.
- I want to help other people around the world.

The presence of 'motivation' propositions that communicate a desire to help other people through the study of languages is notable and resonates with similar responses from School B participants.

Phase 2

Propositions identified in Phase 2 concept map data are presented in Table 50 below.

Table 50 School C Propositions and Themes, Phase 2, Technology & Languages

Theme	School C Propositions Identified in the Raw Data Technology Students Phase 2	School C Propositions Identified in the Raw Data Languages Students Phase 2	Theme
Reasoning	Tech is everywhere, even in languages. Life lies ahead. How technology can make the world a better place.	Building skills and techniques for the benefit of others. Job / career. Learn new skills. Where can this take me? Broaden your horizon. Meet new people. See more things.	**Value Perception**
		Seeing other culture's systems lets us learn about our own. Intercultural communication. People who speak the language keep it alive. Become more worldly.	**Culture**
Connection	The concepts are linked / share an axis.	Change the world. To improve. Be the future. How can I help? How can I improve?	**Motivation / Aspiration**
		To improve and make better. French more practical whereas technology less practical. To be creative. To learn and make new skills and techniques. To design.	**Create / Make**

Theme	School C Propositions Identified in the Raw Data Technology Students Phase 2	School C Propositions Identified in the Raw Data Languages Students Phase 2	Theme
		Use technology. To make and build with skills and techniques, learn new skills.	
		Bring people together. Make people feel heard.	**Connection**
		French won't change the world. Perspective is everything. Quick thinking. Enhances ways of thinking. Tech is made to change the world. Language is made to change a life. Tech is somewhat seen in building the ability to communicate. No greater grand purpose for French. Language lets us understand world affairs. French won't change the future. It isn't in its nature. Tech helps lots physically. Languages can help some personally. Languages are the foundation for humanity. Tech is the bricks we lay to build upon it (humanity). Both types of students use logic to overcome challenges. I'm curious about why certain words are spelled unusually or why sentences are phrased certain ways. Use logic to overcome challenges. Both STEM and languages help students in other areas of school with comprehension and memorisation. What else can I know?	**Reasoning**

Propositions offered by technology participants are limited in number, however it should be noted again that there were only two technology participants at School C. Languages participants produced a similar volume of content in concept map creation and several themes emerged. A summary of themes is provided in Table 51 below.

Table 51 School C Propositions, Phase 2, Technology & Languages

Propositions School C Themes Identified in the Raw Data Technology Students Phase 2	Propositions School C Themes Identified in the Raw Data Languages Students Phase 2
Reasoning Connection	Value Perception Culture Motivation / Aspiration Create / Make Connection Reasoning

Themes identified in Phase 2 were largely similar to those in Phase 1. A notable difference for technology participants was the presence of themes relating to 'reasoning' and 'connection'. However, the propositions provided offered little support to motivation for electing to study technology subjects. Whilst languages participants provided propositions that were identified within the themes of 'value perception' and 'motivation / aspiration', they offered little addition to those in Phase 1. The notable difference for languages participants was with respect to the theme of 'reasoning'. In Phase 2, languages participants appeared to engage purposefully with Phase 2 focus questions to provide propositions that communicate clear consideration of cross-curricular influence. Examples include,

- Tech is made to change the world. Language is made to change a life.
- Tech helps lots physically. Languages can help someone personally.
- Tech is the bricks we lay to build upon it (humanity).
- Both types of students [languages / technology] use logic to overcome challenges.

Propositions such as these allude to the distinction made in Section 4.3 which outlines the different focus between research questions two and three. In these propositions, indications of potential complementary value appear which has implications for teachers. These are not discussed here and are addressed further in Section 4.4.

Follow-up interviews

Follow-up interviews produced similar themes to concept map creation (see also Appendix K). No new themes overall to the study emerged, however the theme of 'learning' did appear in the group interview context. Due to scheduling constraints, follow-up interviews were conducted as one group including technology and languages participants. Given the size of the table required to record propositions, it is provided in Appendix L for reference.

Propositions within the theme of 'learning' include,

- If we are on a Zoom call for example with a German class learning engineering and they could then explore different symbols or different ways that they identify certain things that I think will be interesting.
- But I feel like a lot of skills that you would learn in either subject could be applied and vice versa.
- In French it feels like you think very differently compared to other subjects and I couldn't quite figure out the right words to express that.
- You have to relate everything back and you've got to connect things and build upon them in a different way then let's say math, where we'll go there's one thing, now you learn a different thing.

These propositions indicate potential value as participants consider the possibilities of combining aspects of the two subject areas. Learning with students internationally, studying the same subject but in a different language also appears. However, as discussed above, these propositions speak more to the complementary factors that may appear in the data. Therefore, they are not discussed in this section, and are addressed further in Section 4.4.

In Section 4.3.2 it was stated that technology and languages students in any given context would not necessarily respond the same way to the focus questions presented. However, the propositions offered by School C languages participants do resonate with those provided by technology and languages participants at Schools A & B. With respect to value perception and motivation, participants indicate an awareness of how the study of their respective subjects benefits themselves and has the potential to benefit the wider world. As described in this section, School C technology participants also communicated an element of value through the theme of 'motivation / aspiration', although not as explicitly as those from Schools A and B. No new themes offering additional ways to consider value or motivation were found in School C data. Similar to School B participants in Phase 2 data collection, School C participants also began to show signs of physical exhaustion from the data collection process. The exhaustion did not affect the depth of insight provided in concept maps or follow-up interviews. However, it was noted in that concept map creation was completed more quickly, and follow-up interviews required less time to complete as participants appeared to simply have less to say.

Whilst the data collected for School C did not add materially new information, the data do indicate student awareness of value perception in their subjects. Particularly for languages participants, there is a strong awareness of how the benefits of studying languages may impact them personally. Moreover, that the future opportunities afforded from languages capabilities can influence their immediate context and the wider world. The data therefore support the notion that value perception was a motivating factor for School C participants to select languages as a course of study.

To assist the reader, a high-level summary of themes in this sub-section is provided in Table 52 below.

Table 52 Section 4.3.3 High-level summary

Research Question 2 Section 4.3.3 School C - Themes		
	Technology Participants	**Languages Participants**
Phase 1	**Themes of:** • Motivation / Aspiration	**Themes of:** • Value Perception • Reasoning • Motivation / Aspiration • Culture • Communication
Phase 2	**Themes of:** • Reasoning • Connection	**Themes of:** • Create / Make • Connection • Reasoning

4.3.4 Synthesis of propositions and themes

The preceding sections considered propositions and themes identified in concept maps and follow-up interviews on an individual basis for each school. In the same manner as for investigating conceptualisation in Section 4.2, consistency was found in concept map creation across all three schools with some variation and all responses were considered reliable sources for the investigation of propositions, value perception and motivation. Qualitative content analysis of concept maps and follow-up interviews generated a larger number of themes for propositions than for concepts. This was an expected outcome given the hierarchical nature of concept map design (Novak, 1995). Propositions were arranged into themes and are presented in Table 53 below which maps the themes across all three schools. Themes are presented in the order as they appeared in the data and are not listed in any priority.

Table 53 Proposition Themes, Schools A, B, C, Phase 1&2, Technology & Languages

Themes	School A		School B				School C			
	Technology		Technology		Languages		Technology		Languages	
	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2	Phase 1	Phase 2
Value perception										
Reasoning						Phase 2		Phase 2		
Learning										
Economic development										
Vocation / tech. discipline		Phase 2		Phase 2						
Insight		Phase 2				Phase 2				
Motivation / Aspiration		Phase 2								
Efficiency / Improvement										
Function / Utility										
Making / Creating						Phase 2				Phase 2
Frustration										
Choice										
Passion										
Culture										
Language										
International relations										
Understanding				Phase 2						
Connection								Phase 2		Phase 2
Communication										

Table 53 is superimposed with three numbered rectangles indicating where a concentration of themes is apparent. Concentration of themes is observed at high level and does not mean that other themes present are considered invalid. Cells labelled with 'Phase 2' indicate where themes appeared in Phase 2 data, and not in Phase 1 data for each school and participant cohort.

Rectangle 1 indicates themes expressed with high commonality across Schools A, B, and C. The exception in this case is School C where the theme of learning is notably absent in School C. Offsetting this absence is the increased volume of propositions offered by School C participants in the theme of 'reasoning'. The theme of reasoning for School C will be considered as a possible proxy for 'learning' in the following section. The theme of 'value perception' is well represented for Schools A and B, however it is also notably absent for technology participants in School C. The low technology participant numbers for School C may be a contributing factor, since languages participants clearly communicated value perception and were larger in number. 'Motivation / Aspiration' will also be considered as potential alternative for 'learning' in School C participants as it is present for languages and technology participants, whereas 'learning' is not present.

Rectangle 2 presents a concentration of themes for School B technology participants which is notable given that the pattern is not repeated in Phase 2 data. It is also relevant for further discussion in the following section as it includes the themes of ‘motivation / aspiration’, ‘frustration’, and ‘choice’. As discussed in Section 4.3.2, these themes presented motivation from both the positive and negative perspectives. Their absences in Phase 2 data, and the inclusion of two new themes appearing in Phase 2 indicate a possible shift in perception which is discussed in Section 4.3.5.

Rectangle 3 presents a concentration of themes for School B languages participants with a similar change in pattern to Rectangle 2. There is a strong concentration around languages, cultural and interpersonal themes in Phase 1 and to a lesser extent in Phase 2. However, the themes of ‘reasoning’, ‘insight’, and ‘making/creating’ appear in Phase 2 languages participant responses with clear references to technology related conceptualisation. This also indicates a possible shift in perception as languages participants grapple with technology participant conceptualisations presented to them prior to Phase 2 concept map creation.

Table 53 also indicates that the presence of themes in Phase 2 which were not present in Phase 1 does not appear to follow a specific pattern. As stated, themes are listed in the table in the order they appeared in the data and no priority was given to themes as they appeared in Phase 1 or 2. It would also be possible to list the themes in an alternative or random order, however this would not alter the fact that some themes appeared for Phase 2 and not for Phase 1. To gain deeper insight as to why new themes appearing for Phase 2 appeared this way, the individual components (propositions) of these themes require closer inspection. It is likely that complementary factors between languages and technology subjects are at play. Potential complementary factors are considered with respect to the distinction between research questions 2 and 3 as noted in Section 4.3 and are addressed in Section 4.4.

The following section, Section 4.3.5, discusses the concentration of themes as observed in Table 53 and considers the scattered appearance of Phase 2 themes not present in Phase 1. In the same way as for Section 4.2, Figure 41 below provides guidance of where Section 4.3.5 is located in the overall navigation of this findings chapter. The red arrow indicates Section 4.3.5 where research question 2 is addressed.

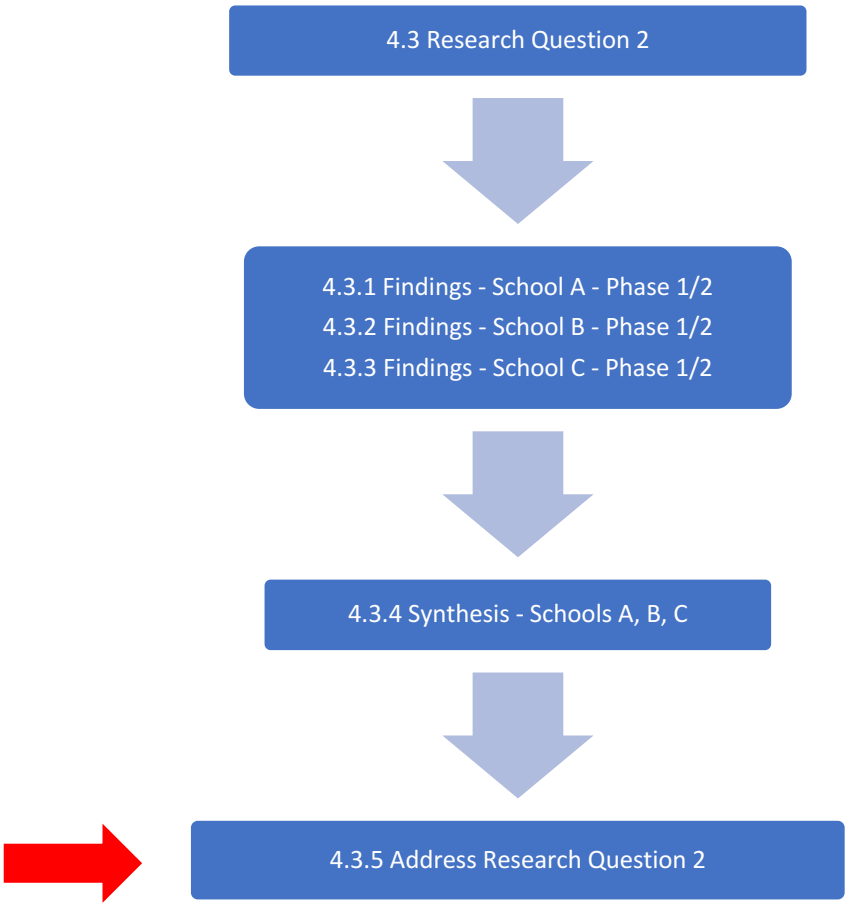


Figure 41 Section 4.3 Navigation

4.3.5 Value proposition and student motivation

This section consolidates findings documented in Chapter Sections 4.3.1, 4.3.2, 4.3.3, 4.3.4, and addresses **Research Question 2**.

> To what extent did value propositions offered by those subjects, and resulting from the conceptualisation strategy, motivate students to study those subjects?

Key statements are highlighted in Boxes 11, 12, 13 14, and 15 to simplify the density of findings for ease of readability with respect to the research question. These key statements are referred to as the basis for discussion of conceptualisation in Section 5.3.

As for Section 4.2, participants were able to offer propositions about the subjects they were studying in accordance with the methods employed by the study. After establishing conceptualisation for their subjects, participants represented relationships between concepts and offered statements (propositions) that convey specific meaning (Novak, 1995). In follow-up interviews, participants continued to express specific meaning through verbal responses. The

framework of ‘concepts, relationships and propositions’ was applied to follow-up interviews to ascertain if further propositions (and themes) could be identified. Sample sections of concept maps are provided in Sections 4.3.1, 4.3.2, and 4.3.3 to illustrate the nature in which participants expressed relationships between concepts to form propositions about their subjects. Variation between the samples indicates diversity in interpretation of the concept mapping task, yet consistency in the outcome of producing meaningful proposition statements. The volume of propositions recorded was reduced into identifiable themes for each cohort of technology and languages participants.

> Participants were able to identify relationships between concepts within their subjects and offer proposition statements about their subjects that conveyed specific meaning.

Box 11

Concentration of themes was identified in three broad areas as per Table 53 in Section 4.3.4, including,

- Themes exhibiting high commonality across Schools A, B, and C.
- Themes communicating value from positive and negative perspectives.
- Themes indicating a potential shift in perspective (Phase 1 / Phase 2).

Themes Exhibiting High Commonality

Themes communicated strongly across Schools A, B, and C include.

- Value perception
- Reasoning
- Learning

Since this section addresses the extent to which value perceptions influence participant subject choice, the above three themes are of first interest. Not only did they exhibit the strongest commonality, but also a theme of primary interest to the research question: value perception.

It is recognised that determining the ‘extent’ to which value perception influenced subject choice is subjective. Participants were not asked to consider factors presented to them and then rank or score them for influence. Rather, participants were allowed to freely communicate conceptualisation through visual methods, and in that conceptualisation, consider factors that influenced them to select the subjects. As stated in the Foreword (Chapter 4.1), this would allow the data to ‘speak’. It is therefore the nature of the propositions offered by participants which helps to uncover ‘extent’.

Across the three schools, participants did produce propositions that communicated value perception. Participants offered propositions which indicated a utilitarian benefit with language including,

- Real life application (School A, technology)
- Better living (School A, technology)
- Engineering is a possible career from DT (School B, technology)
- Jobs requiring Indonesian speakers (School B, languages)
- Requirement for a scholarship, career. (School C, languages)
- To connect different programs, jobs, opportunities. (School C, languages)

The above propositions are considered to be in the expected range of responses given the assumption that education is a preparation for life that requires skills or abilities required for employment. Propositions such as these communicated a sense of value to the individual students which was identifiable across all three schools. Less expected were the direct references to making a positive impact on the wider world. This was through propositions that intended to make an impact *on* the world, and also *within* the world (i.e., within societies and cultures). In these instances, the identification of emotive language indicated a heightened level of perceived value with propositions including,

- Building higher quality of things for people rather than corporations (School A, technology)
- Unlimited designs in the world, many possibilities. (School B, technology)
- Helps with adapting, making you a better person. (School B, languages)
- Communicate with a more diverse range of people. (School C, languages)

As noted in Section 4.3.1, propositions such as those listed above may be considered too nebulous or altruistic for establishing authentic motivation. However, it is important to highlight that participants were presented with a prompting statement in the focus questions which addressed wider factors. Therefore, the presence of such propositions is considered unsurprising, but it is the nature in which they appeared which deserves attention. Participants produced these statements in a concept mapping exercise, which enabled them to state propositions in the context of wider conceptualisation of the subject. That is, these wider reaching propositions were the result of a structured process requiring deep consideration by participants. The strong indication of *future* value at both an individual and societal level suggests that participants do have a sense of value about the subject, and that it is important to them.

> Participants strongly communicated both **present** *and* **future** value at an **individual** *and* **societal** level from studying their subjects.

Box 12

The presence of the theme of ‘reasoning’ supports propositions of value perception. Language used by technology and languages participants indicates that they are involved in the value perception process as they consider complex connections within their subjects. Examples include,

- I believe that each branch of STEM can help with a logical solution. (School A, technology)
- What is the reason for what you have built? (School B, technology)
- Can lead you NOT to accept others’ hardships as just life. (School C, languages)

These propositions under the theme of reasoning exhibit an introspection by participants which suggests that they are not merely subjected to their subjects, but that they are impacted by them. Moreover, that this impact can then impact others, or prompt a reflection of what to do as a result. For example, the School C languages participant response above states,

- Can lead you NOT to accept others’ hardships as just life.

The word ‘NOT’ is capitalised by the participant for emphasis. This statement indicates a more than neutral view of a conundrum presented from learning about a foreign language and culture. Not accepting others’ hardships (with conviction) leads the participant to consider what comes next. The resolution to this proposition was not stated in the concept map, and it remains in tension. However, whilst no answer is provided to help those in hardship, the same participant offers a value proposition of improved perspective:

- Helps you understand your own situation and how well-off you are.

This renewed perspective suggests an implied value as the participant considers the benefit of a higher awareness of quality of life.

The theme of ‘learning’ is also strongly present throughout propositions for Schools A, B, and C. Also present in Section 4.2 (dealing with conceptualisation), learning is considered to add to value perception due to the nature in which it is presented. Participants have an expectation for learning and being introduced to ‘new’ things. Whether this is due to a desire for novelty, or the prevention of boredom is uncertain. However, propositions within the theme of learning suggest a strong association with value. Examples include,

- Growing interest in the world (School A, technology)
- Learning to learn (School A, technology)
- Wanting to build on skills and develop new ones (School B, technology)
- Makes me willing to learn. (School B, languages)

As noted in Section 4.3.4, the theme of ‘learning’ was not specifically identified in School C responses. However, the theme of ‘motivation / aspiration’ is a potential proxy for ‘learning’ in support of the above propositions. Examples include,

- By giving more people the opportunity to learn and help others around the world. (School C, languages)
- Learn through consequences and real-life situations. (School C, languages)

Whilst the above propositions use the word ‘learning’, they are placed in the wider context of living in society or being involved in helping others. They are less applicable to learning in a school context, yet still refer to the *value* of intellectual and personal growth.

> Participants engage in reasoning about the value perceived in their subjects and how this impacts their learning and growth.

Box 13

Value from Positive and Negative Perspectives

Propositions expressing positive and negative perspectives are considered important in the findings. They convey value perception in terms of expectation, which provides a strong indicator of motivation. These perspectives were mostly evident in School A and B technology participants responses. Proposition statements communicating positive motivation included,

- I value a logical answer. (School A, technology)
- Enjoying STEM. (School A, technology)
- I am connected/interested in the lesson/topic we are studying (School A, technology)
- Makes me more creative and makes me calmer (School B, technology)
- I rather enjoy building things, hand-working and metal working (School B, technology)
- I always wanted to do Design Tech (School B, technology)

At face value, the propositions above communicate a broadly positive attitude towards studying technology subjects and could be readily associated with motivation for choosing the subject. However, interleaved with these propositions are statements made by participants that indicate a parallel, and negative perspective. These were identified in Sections 4.3.1 and 4.3.2 and are compared here.

For School A, negative perspectives of value perception appeared in the theme of ‘learning’. Whilst participants produced mostly positive responses, an element of restriction was detected in propositions (appearing on concept maps) including,

- The teacher should lead the students rather than tell them what to do.
- Let students learn from examples rather than a textbook.
- Learning skills without teacher help.

Phrases such as ‘the teacher should’, ‘let students’, ‘without teacher help’, imply a level of desired independence in the learning process that participants possess. At the same time, the

language appears to indicate that this independence is not fully experienced. This notion was supported in statements made in Phase 1 follow-up interviews, including,

- Teachers should lead kids in the right direction.
- Give them the direction to go on and give them basic skills to build on, so they can get where they need to be.
- No other class can let you do that for a major work.

The use of modal verbs and exclusive language ('no other class can let you do that') suggests that participants have a strong sense of what is valuable to them with respect to the subject and yet are not entirely able to obtain it. There is an element of tension in the propositions.

For School B participants, there is a similar element of tension, however with an added dimension. School B technology participants expressed value through negative perspectives with propositions that were themed as 'frustration'. As noted in Section 4.3.2, participants had expectations of experiencing 'X' and yet experienced 'Y'. This was evident in propositions including,

- I thought this subject would have more hands-on tasks.
- I thought this subject would be mainly design and the design process, but it was mostly research assignments.
- Not much creativity in class.

Frustration in this case reflects the 'extent' to which value played a role in these participants electing to study technology. It is possible that the above propositions may not have been offered if participants' expectations for the subject had been lower.

Highlighting negative perspectives in the findings is not intended to be a critique of the delivery or curriculum content of the individual subjects that participants were studying. The research

> Participants expressed value from **positive** *and* **negative** perspectives in terms of **expected** versus **actual** experiences.

Box 14

question addresses value perception based on participant conceptualisation of their subjects independent of the content. Curriculum content is prescribed and there is flexibility in how it is addressed and delivered. Therefore, awareness of student expectations of value, whether positive or negative, has implications for teachers as they plan for and implement the subjects. This will be addressed further in the discussion chapter.

Themes Indicating a Potential Shift in Perspective

Table 53 at the beginning of Section 4.3.4 illustrates that several new themes were identified for participants at all three schools between Phase 1 and Phase 2. The emergence of new themes did not indicate any clear pattern and appeared to be evenly spread across the three schools. In order of appearance within the raw data, the themes include,

- Reasoning
- Vocation / technology discipline
- Insight
- Motivation / aspiration
- Making / Creating
- Understanding
- Connection

The themes are considered here for new or previously unknown value that participants may have held but did not express in Phase 1. On closer inspection, only the theme of 'understanding' for School B technology participants offers potentially new insight. Propositions indicating value, although not specifically themed as 'value perception' include,

- Increase understanding between us (society) and the environment (materials, consumerism, ethics, habits & change, equality).
- To understand opportunities in the world to design.
- Understand new concepts within technology.

It is possible that School B technology participants valued a deeper understanding of society and the environment that was offered by studying technology. Similarly, that studying technology would also offer a deeper understanding of the opportunities to design, and that this was also considered valuable. A connection could also be drawn between the ability to 'understand new concepts within technology' and the theme of 'learning'. Whilst a sense of value is present in these propositions, it is recognised that Phase 2 technology participant propositions were created after having been exposed to Phase 1 languages participant propositions. Whether the influence from languages participants prompted technology participants to build new value perception, or whether it simply prompted the memory of pre-existing value perception is uncertain. However, the presence of these propositions is noted here as they represent the strongest links to value and motivation in new themes appearing for Phase 2. All other themes speak more directly to complementary value between the subjects which is addressed in the following section with respect to research question three.

The volume of propositions offered across all three schools indicates that participants were able to make meaningful statements categorised across a number of themes. Variation in how propositions were illustrated or stated on concept maps was outlined in Sections 4.3.1, 4.3.2, and 4.3.3 which demonstrated that participants could respond with consistency in accordance

with the research method. Within the variation, broad areas of theme concentration were observed which enabled examination of propositions to determine the 'extent' to which value offered by subjects motivated students to select those subjects. At each school, value perception was identifiable as a motivating factor for studying the subject. This was evident through impact on the individual and wider society. A distinction between having an impact 'on', and impact 'within' society could be made, implying that participants included these as motivating factors. Participants also included the lack of value, or lack of expectations met as negatively impacting their experiences of the subject. This was not considered a critique of the subject content or delivery. Rather it was considered a further expression of the extent to which value offered by the subject was a motivating factor. Participants sought and expected value and expressed frustration about its absence. Findings within these data suggest that value offered by the subjects play a meaningful role for participants (students). This has implications for teachers which will be addressed in the discussion chapter.

Participants expressed a more than neutral extent of value perception as a motivating factor in studying their subjects.

Box 15

4.4 Relationships and Complimentary Value – Research Question 3

This section addresses research question three (RQ3). It examines the extent to which there are complimentary value propositions between languages and technology subjects, as recorded by participants in the study, and how students express them. RQ3 (below in bold) is the second research question underlying the primary research question which examines conceptualisation. For context at this point of this findings Section, the three research questions are presented again below.

RQ1 How do students conceptualise the technology and languages subjects they undertake, independently from notions of assessment or curriculum?

RQ2 To what extent did value propositions offered by those subjects, and resulting from the conceptualisation strategy, motivate students to study those subjects?

RQ3 To what extent are there complementary value propositions between languages and technology subjects, and how do students express this?

In accordance with the methodological frame of concept mapping (Novak, 1995), participant drawn concept maps were analysed for concepts, relationships, and propositions. Whilst these three major components of concept maps were considered together on each response,

‘concepts’ mostly informed RQ1 and ‘propositions’ mostly informed RQ2. As demonstrated in Sections 4.3.1, 4.3.2, and 4.3.3, ‘relationships’ were identified amongst connected elements drawn on concept maps to form propositions (statements of meaning). As stated in Chapter 3 Methodology, this application of concept maps reflects the position taken by Schreier (2014) which allows the “researcher to focus on selected aspects of meaning, namely those aspects that relate to the overall research question”. The application of the methodology is reiterated here as it pertains to the Phase 1 / Phase 2 nature of the study. To uncover potential complementary value between the two participants groups of technology and languages participants, it was necessary to repeat the concept mapping exercise with revised focus questions arising from Phase 1 responses.

RQ3 supports the objectives of ‘Opportunity’ and ‘Understanding’ as stated in Section 1.4 Research Questions. The notion of ‘opportunity’ was included to determine how students identify value in their subjects, where new value may exist, and how that value can be leveraged. The notion of ‘understanding’ was included as an objective to determine whether technology and languages participants identified overlapping, or complementary value propositions between these two subject areas. Findings in this section are not considered to draw conclusive statements about whether technology students should also study languages, or vice versa. Rather, RQ3 provides a link to examining RQ1 and RQ2 in the context of the disruptive innovation frame, which is addressed further in the discussion chapter. This section therefore recognises the importance of reciprocal interest in technology and languages subjects by either participant group in the context of this study. Moreover, it recognises the implications that understanding of previously unknown value propositions in *any* subject may influence *any* students to make better, or previously unconsidered subject selections.

As stated in Chapter 3 Methodology, participants were provided with focus questions and images of typical concept map construction as stimulus material. Phase 1 focus questions were presented to Schools A, B, and C as shown in Box 16 below.

Phase 1

- How do you conceptualise STEM / Technology Education / Languages?
- What factors influenced your sense of value in making this subject selection?

Box 16 Phase 1 Focus Questions, Schools A, B, C

Chapter 3 describes the process by which concept maps were analysed for the purpose of developing Phase 2 focus questions for Schools A, B, and C. Revised focus questions were developed for technology and languages participants in Schools A and B, as shown in Box 17 and Box 18 below.

Phase 2 – for technology students, schools A & B

When asked to conceptualise their subjects, students from **languages** classes generated 'meaningful statements' that included…

- To better, or truly understand…to gain understanding…understanding other people…deepening understanding
- To learn…benefits your learning abilities…easy, fun to learn
- Improves memory skills…intelligence across subjects
- Beneficial to the brain…both sides of the brain
- Connection…lets me connect

If you were to consider those as propositions **to you** for your subject, how might you re-conceptualise your subject?

What else might you consider?

Box 17 Phase 2 Focus Questions, Technology Students, Schools A & B

Phase 2 – for languages students, schools A & B

When asked to conceptualise their subjects, students from **technology** classes generated 'meaningful statements' that included…

- To make, build… with skills and techniques…learn (new) skills
- To design…solve (problems)
- To create…be creative
- Ask why, how… use logic
- To improve…make better

If you were to consider those as propositions **to you** for your subject, how might you re-conceptualise your subject?

What else might you consider?

Box 18 Phase 2 Focus Questions, Languages Students, Schools A & B

School C was added to the study after Phase 1 and 2 data had been collected for Schools A and B. This was because it was not considered that data saturation had been reached. For consistency, School C Phase 1 data were also analysed using the same method as for Schools A and B, to examine for additional 'meaningful statements' arising from participants. Additional statements that influenced the development of Phase 2 focus questions presented to School C included,

Technology participants

The future...be the future

Change...change the world...change someone's life

Languages participants

To help...help others

Speaking...expressing myself...helping others understand (translate)

Appreciation, to appreciate...to appreciate one's situation.

Phase 2 focus questions presented to School C included the above additions. They are shown in Box 19 and Box 20 below.

Focus Questions

When asked to conceptualise their subjects, students from **technology** classes generated 'meaningful statements' that included…

- To make, build… with skills and techniques…learn (new) skills
- To design…solve (problems)
- To create…be creative
- Ask why, how… use logic
- To improve…make better
- The future…be the future
- Change…change the world…change someone's life

If you were to consider those as propositions **to you** for your subject, how might you re-conceptualise your subject?

What else might you consider?

Box 19 Phase 2 Focus Questions, Technology Students, School C

Focus Questions

When asked to conceptualise their subjects, students from **languages** classes generated 'meaningful statements' that included…

- To better, or truly understand…to gain understanding…understanding other people…deepening understanding
- To learn…benefits your learning abilities…easy, fun to learn
- Improves memory skills…intelligence across subjects
- Beneficial to the brain…both sides of the brain
- Connection…lets me connect
- To help…help others
- Speaking…expressing myself…helping others understand (translate)
- Appreciation, to appreciate…to appreciate one's situation

If you were to consider those as propositions **to you** for your subject, how might you re-conceptualise your subject?

What else might you consider?

Box 20 Phase 2 Focus Questions, Languages Students, School C

As stated above, RQ3 was not included to imply that technology and languages students should study reciprocal subjects. The focus questions stated above ask participants to consider the propositions and how they might re-conceptualise their subjects. In addition, they are asked what else they might consider. They are not explicitly asked whether they would study technology or languages subjects. This distinction is made to minimise any influence of stimulus that may be considered as leading the participants in their responses.

Sections 4.4.1, 4.4.2, and 4.4.3 examine the data for Schools A, B, and C respectively. These sections ascertain whether participants re-conceptualise their subjects and to what extent identify complementary value propositions in technology and languages subjects.

4.4.1 School A – relationships and complementary value

School A participants created Phase 2 concept maps from revised focus questions containing propositions from School B languages participants. There were no languages participants at School A. School A technology participants all studied the iSTEM subject.

Conceptualisation

Noticeable changes in conceptualisation were evident in School A Phase 2 data. The changes were predominantly within the theme of 'learning', as shown in Table 54 below.

Table 54 Concepts and Themes, School A

School A – Concepts and Themes Identified in the Raw Data Technology Students		
Theme	**Concepts**	
	Phase 1	**Phase 2**
Vocation / technology discipline	job/employment future career Elon Musk Tesla innovation careers military hardware	Non-traditional engineering jobs
Learning	Thought process. Teacher to class learning. Learning new skills. reality (of class experience) practical skill development	brain memory connection propositions understanding learn history skills

As noted in Section 4.2.1, School A participants communicated a strong conceptualisation of being involved with the learning process in their subjects. An expectation of interaction with their teacher and the acquisition of skills and knowledge was present. After exposure to School B languages propositions, School A technology participants continued to communicate a strong concept of 'learning' within their subjects, albeit with a shift in perspective. Words including 'brain', 'memory', 'understanding', and 'connection' were stated in Phase 2 focus questions and then appeared as concepts in Phase 2 concept maps. Whether they were recorded by participants purely because they were prompted by them, or whether they did form a new conceptualisation is uncertain. However, they are present on concept maps which, at a minimum, indicates an awareness of, or willingness to consider the perspectives of participants from other subjects. Also noteworthy is that Phase 1 concepts appeared within what could be an expected range. Conceptualisations of 'career', 'employment', 'innovation' are complemented by the 'military', and recognisable brand names such as 'Tesla' and 'Elon Musk'. These concepts could be described as a utilitarian conceptualisation. That is, the study of

iSTEM leads to practical and recognisable outcomes. The presence of 'non-traditional engineering jobs' also appears as a shift in perspective as participants indicated the capacity to conceptualise their subject in a previously unconsidered manner.

No new themes were identified for School A participants in Phase 2 concept maps.

Complementary Value

School A technology participants produced propositions indicating a shift in perspective across several themes in Phase 2. Identifiable on concept maps, they include the following (themes shown in parentheses),

- Better understanding of others (value perception)
- Building high quality things for people rather than corporations (value perception)
- Link knowledge from my brain to be able to come up with new solutions (reasoning)
- But through iSTEM you understand the language of math and tech (reasoning)
- Maths transcends language barriers (reasoning)
- Is similar to language, you are analysing the world (learning)
- Higher level of / gain understanding (learning)
- Learn how to help others (learning)
- Originality of texts in native language (learning)
- Engineering without borders (vocation / technology discipline)

These propositions are highlighted due to their relationship to School B languages participants propositions. Noteworthy is that the propositions do not reference curriculum content directly. Rather, they are high-level reflections that point towards a widening awareness of overall benefit, or value of their subject. The propositions focus less on the technology or products that iSTEM produces and present a greater interpersonal awareness through phrases including 'better understanding of others' and 'things for people rather than corporations'. To see how this change manifested on concept maps, two examples are discussed.

There is no indication that participants attempted to create a direct link with language learning. However, participants did consider the broader concept of language in the context of iSTEM in propositions including,

- Maths transcends language barriers.
- Is similar to language, you are analysing the world.

Examining the concept map in which the above two propositions were found also indicates that participants did not necessarily present wider awareness with visually striking or overly complex responses. Figure 42 below illustrates the response. The participant used a combination of direct statements, and the concept map structure to communicate revised propositions. Figure

42 is superimposed with labels ‘C’ (concept), ‘P’ (proposition) and red lines/arrows indicating relationships between connected elements.

- P1 indicates a direct proposition statement, separate from the overall concept map structure.
- P2 indicates a direct ‘relationship’ between iSTEM as a concept, and the value propositions of ‘math transcends language barriers’ and proceeding therefrom, ‘universal understanding’.
- P3 indicates the relationship between iSTEM and the connected elements of a ‘heavy cognitive load’, ‘higher level of learning’, leading to the proposition of ‘higher level of understanding’.

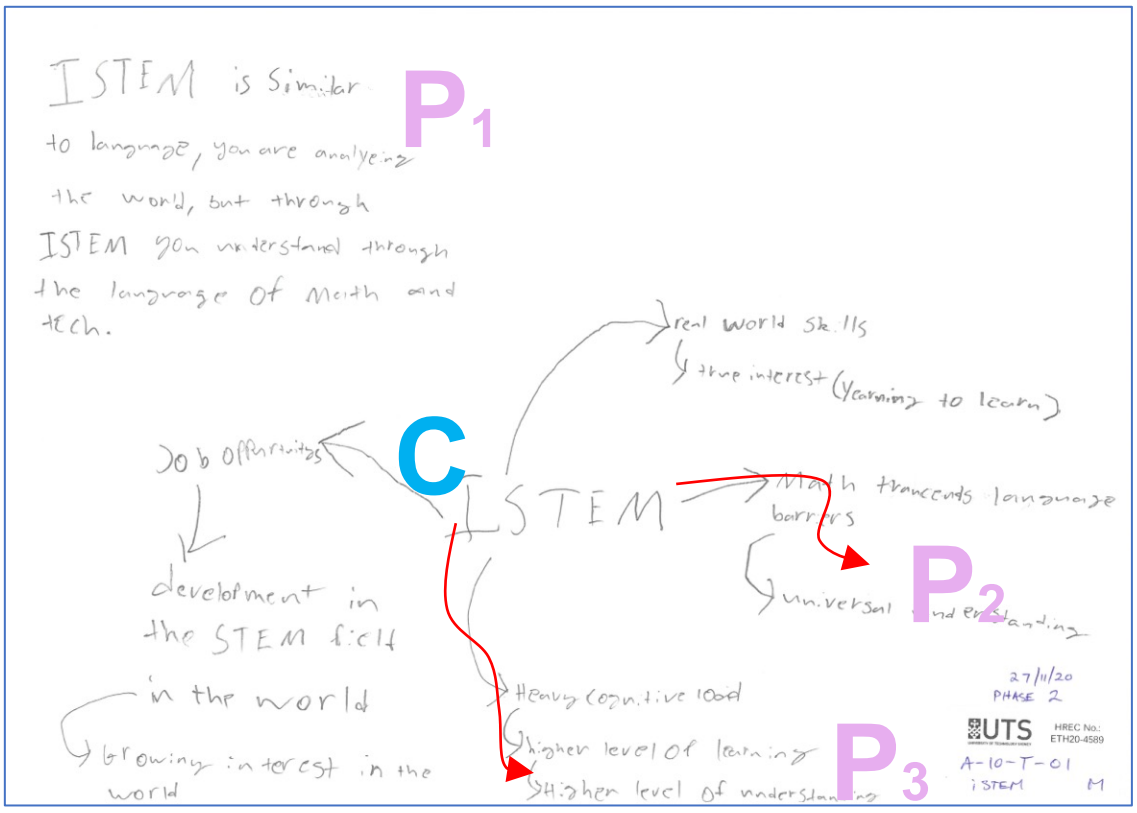


Figure 42

No colour or imagery is used on the concept map in this example. However, the combination of direct statements and concept map structure illustrates that the participant can express unique propositions, and more complex reflections based on a series of elements. Moreover, that these revised propositions were developed from stimulus based on other student propositions.

Figure 43 below illustrates the response that produced the new conceptualisation of ‘non-traditional engineering jobs’. This example is provided as there is less focus on technological references and greater focus on the outcomes of a reconceptualised view of ‘engineering’. Figure 43 is superimposed with labels ‘C’ (concept) and ‘P’ (proposition) and red lines/arrows

indicating the relationship between connected elements. A green area ‘A’ is also indicated. The structure of this concept map is more complex and convoluted than the previous example, however the concept map structure still enables concepts, relationships, and propositions to be identified.

For this participant, Phase 2 has generated a concept map with ‘non-traditional engineering jobs’ as a central element to which proposition statements are directly linked. ‘Helping others’ and ‘building high quality things for people rather than corporations’ (P1) indicates a greater awareness of human, or interpersonal factors as noted above. ‘Engineering without borders’ (P2) is also linked with the central concept of non-traditional engineering jobs yet is connected through elements of ‘improving peoples’ lives’ and ‘humanitarian’.

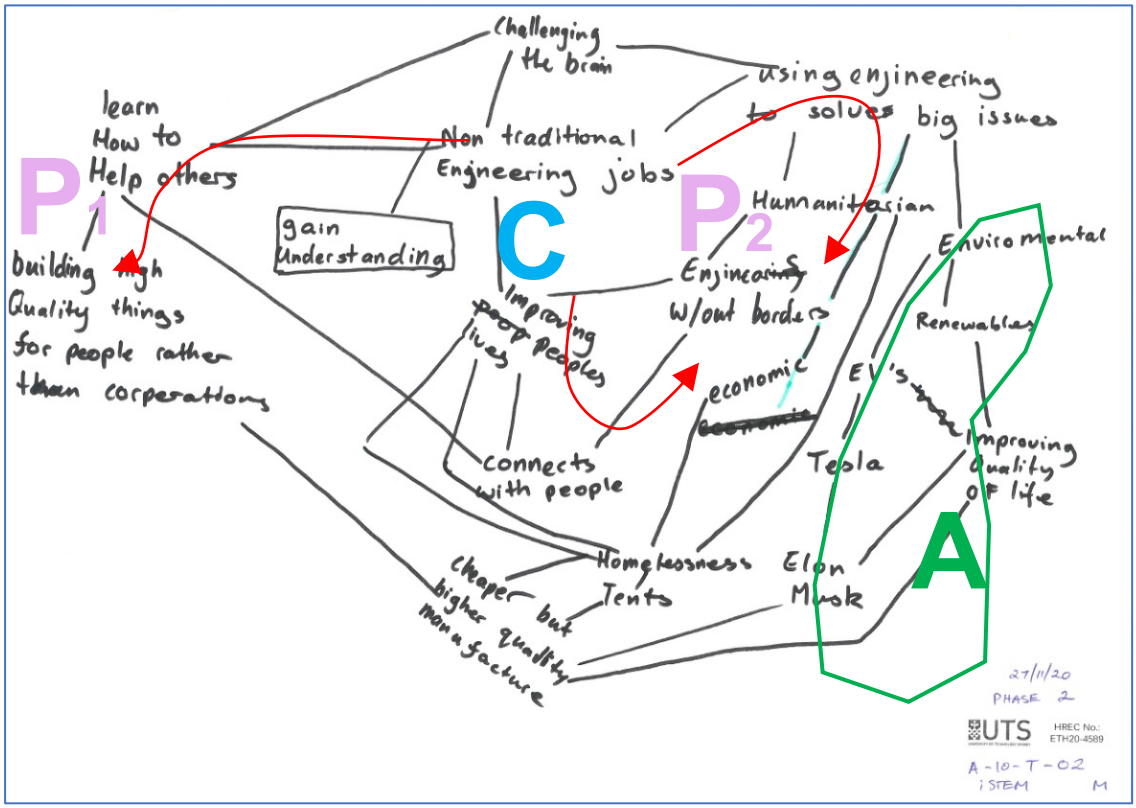


Figure 43

Area A shows that the participant still recognises technological elements as forming an integral part of the overall conceptualisation. However, the focus is lessened. Figure 43 does not present any direct references to languages or learning languages. The change in perspective for this participant appears to emerge from prompts in revised focus questions relating to people and understanding them. This suggests that when prompted, this participant was able to consider value perceived by languages participants and communicate that value in the context of iSTEM. Propositions such as ‘challenging the brain’ (evident in Figure 43 above), and ‘link

knowledge from my brain (listed above) indicate that participants' perception of cognition and learning are also heightened to some degree.

Follow-up Interviews

School A follow-up interviews elicited further responses that contributed to a shift in perspective in Phase 2 data collection, both in conceptualisation and propositions (see also Appendix I).

With respect to conceptualisation, analysis identified 'concepts' within what was determined as the theme of 'insight'. Concepts additional to those in concept maps included,

- Engineering mindset
- Design languages
- Respect
- Honour

These concepts support the notion that participants were able to widen their perspective beyond the immediate concepts of iSTEM, such as the component subjects of STEM, or specific technologies. Participants reflected on the impact of engineering as a way of thinking and the way in which design could be used as a language to communicate the realisation of products and projects. The shift is subtle, yet noticeable. The Phase 1 theme of 'vocation / technology discipline' provides an example. In Phase 1, participant responses included the concepts of,

- Mindsets on working
- Engineering, more of a physical thing

In Phase 2, similar concepts were offered and were themed as 'insight'. They include,

- Humanitarian side of engineering
- Engineers without borders
- Engineering mindset

Propositions made in follow-up interviews also made additional contributions to the presence of complementary value propositions. Responses appeared to be less focussed on functional design or engineering outcomes, and more focussed on the impact of products on people. Verbal responses provided the opportunity for full sentence responses including,

- The connection is really cool because there's a lot more in technology today than just getting the product as efficient as possible.
- I think feeling like you're doing something to help people would make students take more consideration in what they do in their projects.
- Not just making a project, they're designing something for someone.
- How could you build something that will benefit others?

The statements did not dominate the follow-up interviews; however, the shift is identifiable. Noteworthy in this context is that more direct awareness of language and cultural factors was identified in Phase 1 follow-up interviews. The awareness was with respect to working with people from other cultures who move to Australia, or work with people in Australia. Propositions included,

- Need better language courses in Australia.
- Benefited [benefits] people if you've got a population that can speak a wide array of languages.
- More attractive prospect [moving to Australia].

School A technology participants did not have languages participants amongst them in follow-up interviews. Nor had they been exposed to Phase 1 languages participant responses at that point. However, School A technology participants had a modicum of awareness of language and cultural factors impacting their subject, which they carried through into Phase 2. This suggests that for this cohort, the value presented by language and intercultural awareness could be promoted and enhanced.

Where there was less indication of interpersonal factors, or broader notions of language and culture in Phase 1, School A technology participants were able to recognise complementary value when prompted in Phase 2. The nature of change in perception as recorded (and illustrated above) suggests a meaningful benefit was created for School A technology participants from the consideration of value in languages subjects.

To assist the reader, a high-level summary of this sub-section is provided in Table 55 below.

Table 55 Section 4.4.1 High-level Summary

Research Question 3 Section 4.4.1 School A - Relationships and Complementary Value		
Complementary Value	**Technology Participants**	**Languages Participants**
Found in...	**Themes of:** • Non-traditional engineering jobs • Learning	There were no languages participants at School A.
Expressed in/as...	**Propositions communicating:** • Building high quality things for people rather than corporations • Better understanding of others • Learn how to help others • Humanitarian side of engineering • Engineering without borders	This cell is left intentionally blank.

4.4.2 School B – relationships and complementary value

School B participants created Phase 2 concept maps from revised focus questions containing propositions from Phase 1 participants at Schools A and B. School B included both technology and languages participants.

Conceptualisation

Conceptualisation did not vary substantially for School B Phase 2 technology or languages participants. Moreover, there was little evidence to suggest that participants broadly reconceptualised their subjects based on the propositions of participants from either technology or languages subjects. Table 56 below recaps the Phase 2 concepts presented by technology and languages participants.

Table 56 School B Concepts and Themes, Phase 2, Technology & Languages

Themes	School B – Concepts Identified in the Raw Data Technology Students Phase 2	School B Concepts Identified in the Raw Data Languages Students Phase 2	Themes
School Subject	design and tech theory & prac fluid subject	French Language knowledge	**School Subject**
Creating / Making	design different ideas creativeness building stuff creativity	create	**Creating / Making**
Value Perception	job opportunities future jobs fun, social	Connection benefit of the subject brain break future layering skills skills improve creativity	**Value perception**
Reasoning	Understanding innovation improvements intelligence across subjects	Ask Solving improve	**Reasoning**
Learning	learn applying learning life skills applying understanding learning abilities analytical	Learning more (about culture)	**Learning**
Culture	connect world view principles	culture country Friendship Traditions History Society Food Beliefs Attractions	**Culture**

		Fashion Unity Understanding empathy	

Despite conceptualisation remaining relatively stable across Phases 1 and 2, some reconceptualisation did occur. Table 56 above is superimposed with red lines/arrows to indicate where concepts across themes suggested complementarity. The notions of culture and connection appeared to resonate with technology participants as the concepts of 'connection', 'world view' and 'principles' became evident. The presence of 'intelligence across subjects' also suggests that technology participants considered technology subjects in the wider space of other subjects; in this case prompted by languages. However, the links are tenuous. Less expected were the references by languages participants to the concepts of 'create', 'skills', 'improve', and 'creativity'. These concepts were not present in Phase 1 data and indicate that languages participants considered languages acquisition in terms of a skill to be developed and improved. Possessing the ability to communicate in an additional language could readily be described as a skill, however the participants did not consider it in that manner in Phase 1 responses. The concepts of 'ask' and 'solving' present in languages participant responses are noteworthy for similar reasons. Whilst perhaps being a matter of semantics, the use of different words to describe ability with languages suggests the consideration of a different perspective.

Complementary Value

School B languages participants produced a large number of propositions in Phase 2 which are shown in Table 45 in Section 4.3.2. Due to the size of the table, it is not reproduced here. Rather, propositions that indicate a shift in perspective or complementary value are listed and discussed in this section.

Technology participants produced fewer propositions than languages participants overall in Phase 2. However, there is evidence that the revised focus questions based on languages participants' propositions made some impact. Technology participant propositions demonstrating the most salient evidence of this impact include,

Theme: Value Perception

- Languages can be helpful.
- Benefits people around you.

Theme: Understanding

- Increase understanding between us (society) and the environment (materials, consumerism, ethics, habits & change, equality).
- Deepen understanding of others needs and problems, think beyond ourselves.
- To understand opportunities in the world to design.
- Relate to their point of view.

- Understanding other people.

Theme: Connection

- Through tech we can design and create new things that bring people closer.

Theme: Learning

- Gives you different perspectives which enhance learning abilities for many other things.
- Uses both sides of the brain.

Theme: Reasoning

- Understanding peoples' reasoning for doing something that way.
- Different people have different perspectives within design that can have many different outcomes.

In this list of propositions above, those of first interest to the study are located within the themes of 'understanding' and 'connection'. These propositions speak to the study's objectives of 'opportunity' and 'understanding' and provide insight into participant reflections on the broader awareness of cultural, global, and human factors in technology subjects. Whether the participants stated these propositions simply because they were prompted to by the stimuli present in revised focus questions is uncertain. However closer examination of the concept maps where these propositions occurred provides further insight into how participants developed these new propositions. Two examples are presented.

Figure 44 below illustrates a concept map in which above listed propositions of 'understanding' are found. This example is pertinent because it is the only teacher participant response in the study.

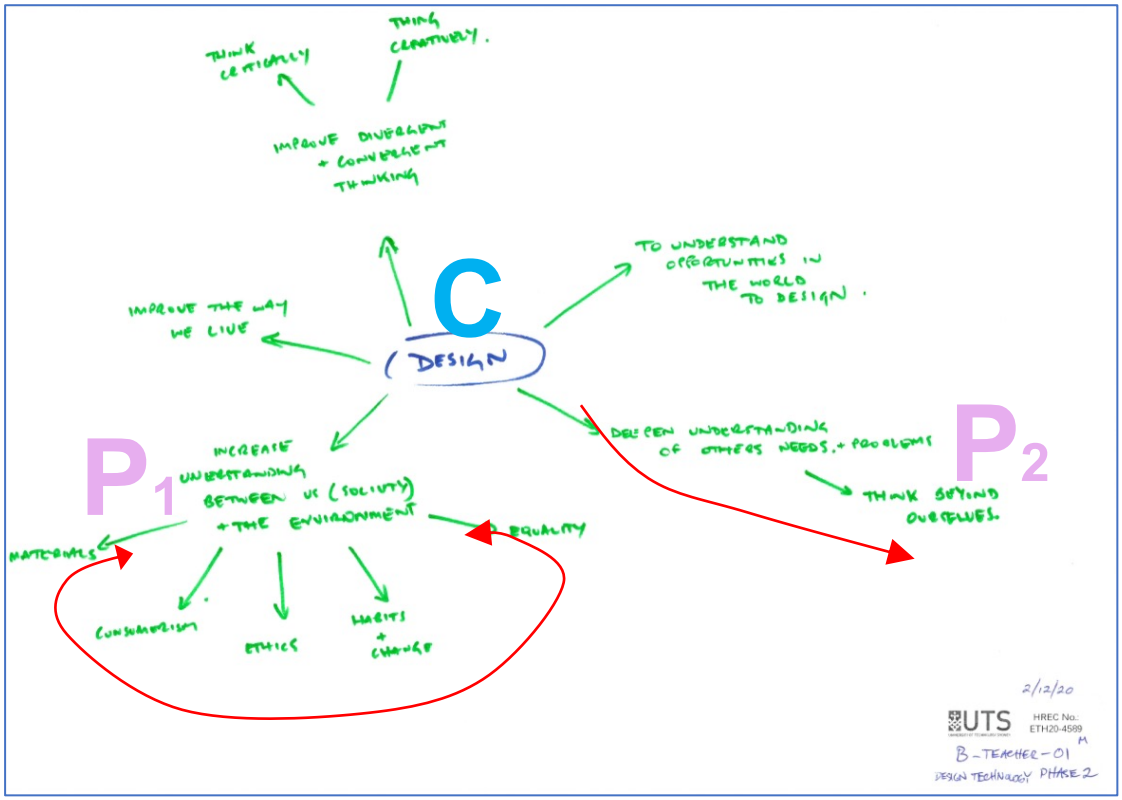


Figure 44

Figure 44 is superimposed with labels ‘C’ (concept) and ‘P’ (proposition) and red lines/arrows indicating the ‘relationship’ of connected elements. The concept central to this response is ‘design’. P1 ‘increase understanding between us (society) and the environment’ is a proposition derived directly from the concept and illustrated as supported through the relationships created by the connected elements underneath the statement. P2 ‘deepen understanding of others’ needs and problems’ is also directly linked to ‘design’ and then connects to form a second linked proposition of ‘think beyond ourselves’. With respect to concept map morphology, this concept map illustrates consistency with other examples presented thus far and is typical of responses at all schools. This is noteworthy, given it is the only teacher participant response. That is, the teacher did not materially interpret the task differently to student participants. More important in this case is that the propositions are not simply stated on the concept map as ideals but are shown to be considered and constructed within the concept mapping task. The elements supporting P1 also illustrate a distinct lack of what might typically be described as ‘technological’ references, in favour of more human or societal factors such as ‘consumerism’, ‘ethics’, ‘habits & change’, and ‘equality’. P2 supports the theme of understanding in this response with deeply reflective statements that ‘deepen understanding of others’ needs and problems’ and prompt the participant to ‘think beyond ourselves’. Despite the simplicity of morphological structure presented in this concept map, there is a latent energy in the response. This suggests a wider perspective that could result in an extended implementation of the technology subject taught, to explicitly include global, social, and cultural factors.

Figure 45 below illustrates a concept map in which the above listed proposition within the theme of ‘connection’ is listed. The example is a student participant response.

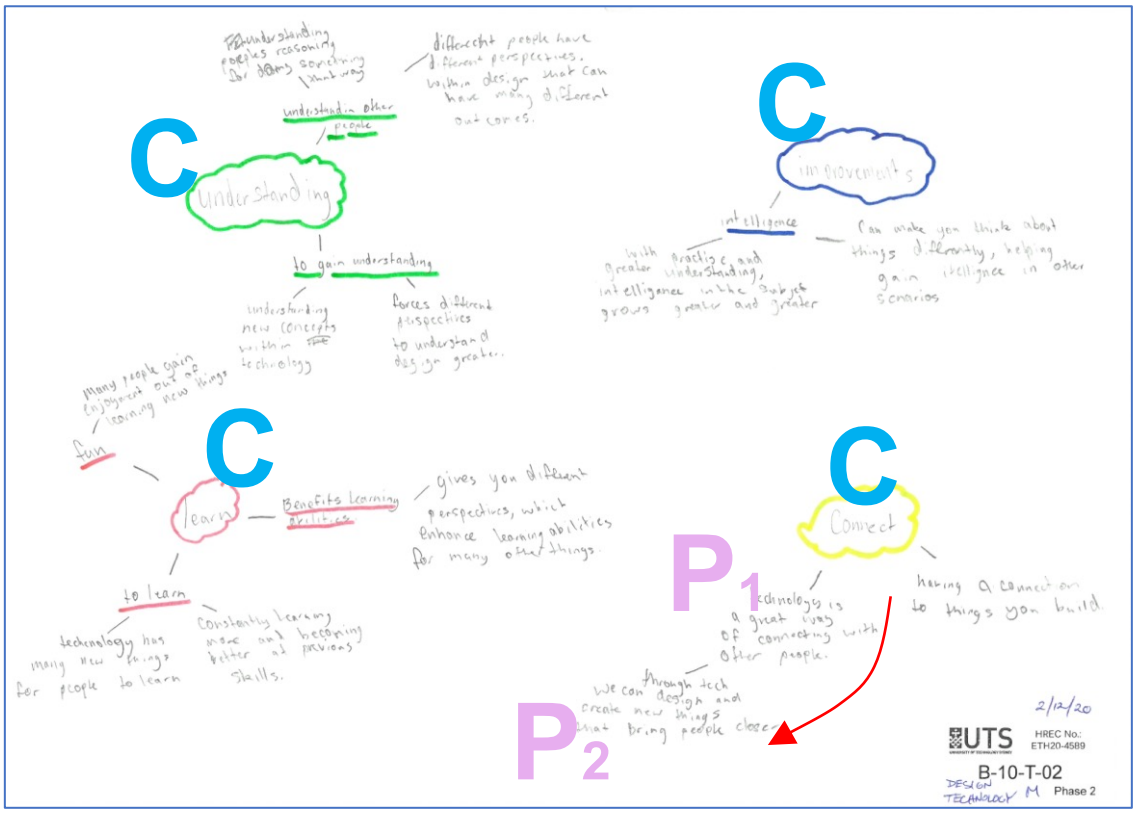


Figure 45

Figure 45 is superimposed with labels ‘C’ (concept) and ‘P’ (proposition) and a red line/arrow to indicate the ‘relationship’ of connected elements. In this Phase 2 response, the participant maintained the concept map structure with concepts clearly indicated. Each concept is supported by connected elements that are subordinate to the concept indicating that the participant maintained the structured approach set by the concept mapping task. Proposition P2 is linked to the concept of ‘connect’ through proposition P1. The whole concept map is shown above to demonstrate consistency with the concept mapping task and that participants did not simply resort to writing what could be construed as the ‘correct answer’. An enlargement of P1 and P2 is shown in Figure 27 below for detail.

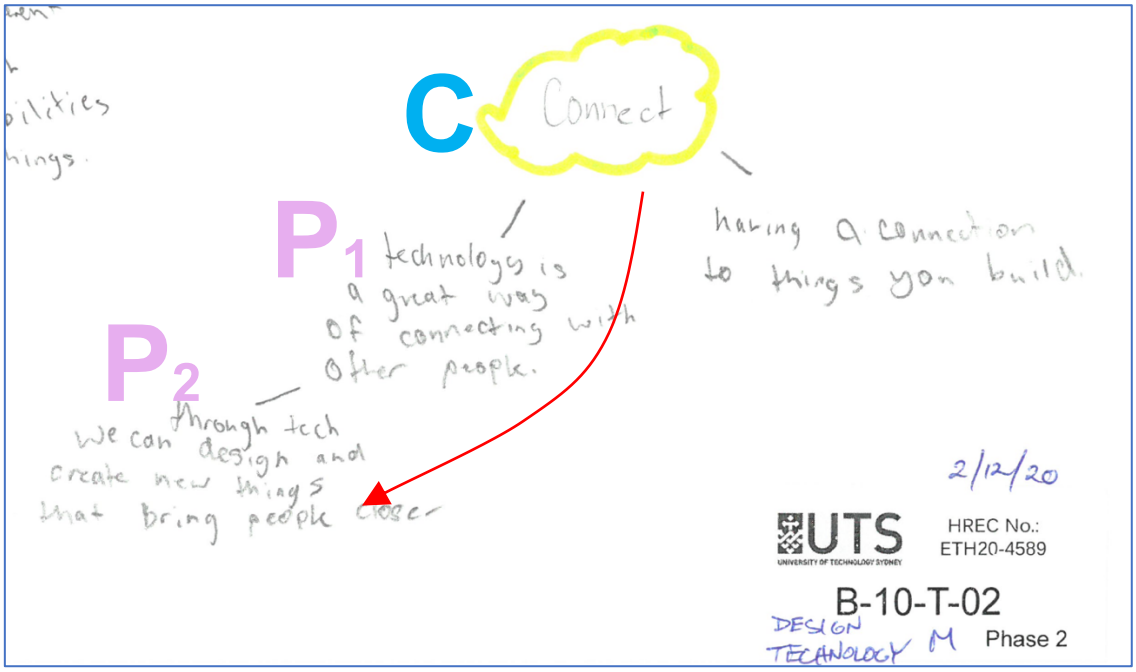


Figure 46

Figure 46 above illustrates that despite the simple structure of this concept map, care needs to be taken in identifying propositions due to small handwriting which is difficult to read. In this case the participant does not specify which technologies can 'bring people closer'. However, the presence of this line of thinking indicates that the participant is aware of human factors and that technology subjects can play a role in improving human interaction.

The examples of Figure 45 and Figure 46 above, together with propositions listed above suggest that technology participants were impacted by Phase 2 focus questions. The propositions were not dominant in the complete list of Phase 2 propositions identified in the raw data. However, their presence and depth of reflection point towards the potential to explore broader societal and cultural factors within the subject.

Languages participants produced approximately twice the volume of propositions in Phase 2 data collection, as shown in Table 45 in Section 4.3.2. At high level, responses appeared to further emphasise and reinforce perceived value in studying languages with no material impact from technology participants' influence. Despite this renewed emphasis, there were indications that languages participants had considered the propositions in revised Phase 2 focus questions. Responses indicating a shift in perspective based on technology participant propositions occurred only within the theme of 'insight'. They include,

- Different people perceive hands-on learning and typical in-class learning differently...often in-class learning can be more fruitful but less enjoyable.

- I would reconceptualise languages in the sense that I would want to learn how to be creative in this language....I'd probably want to learn how to do things like poetry/creative writing like we do in English class.

Figure 47 below illustrates where the above listed propositions occur in the raw data. The concept map consists mainly of written statements. However, the response illustrates a consistent morphology with other concept maps in the cohort. Figure 47 is superimposed with labels 'C' (concept), 'P' (proposition), and red lines/arrows indicating the relationship of connected elements. Text appearing as grey on the concept map was originally written in reflective silver marker pen resulting in lower quality scanning. For ease of reading, the proposition is therefore reproduced (in red) adjacent to its position on the concept map.

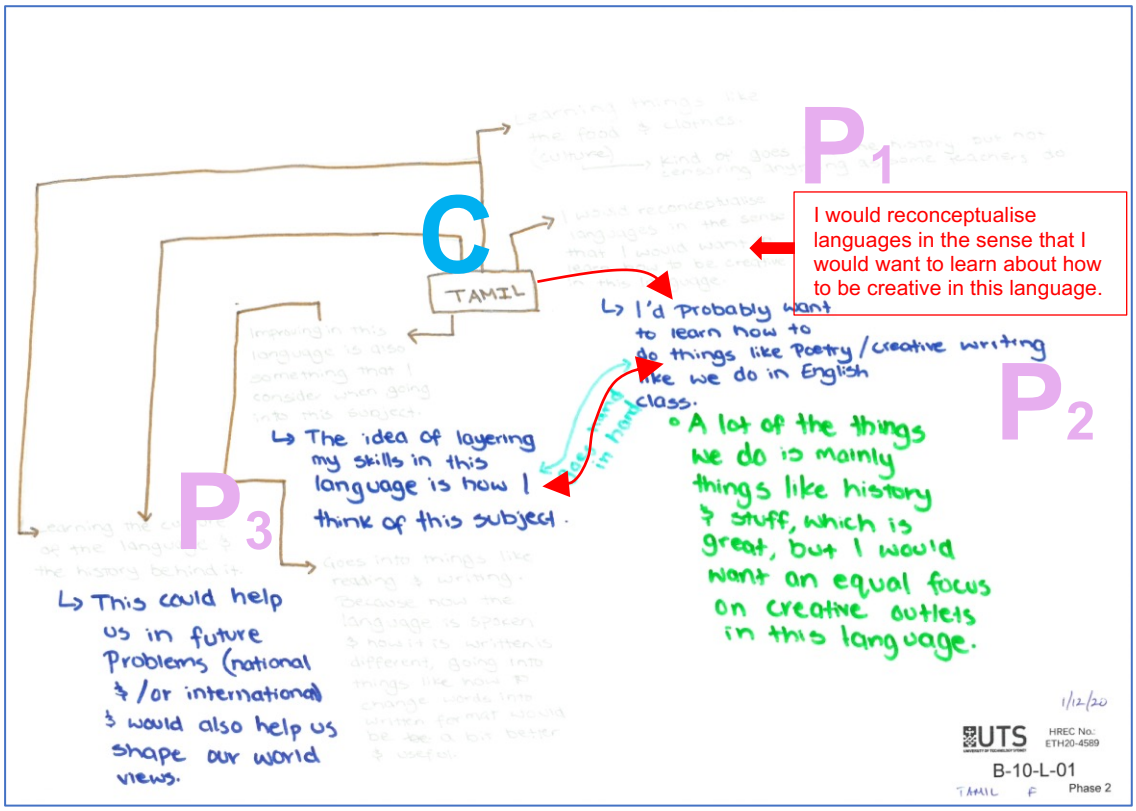


Figure 47

Figure 47 is an example of important data that communicate meaning, but occur only once in the data (Drisko & Maschi, 2015). In Phase 2, the language of Tamil is the central concept to which propositions are linked. P1 is linked directly to the central concept, and P2 proceeds immediately from P1. This is the only response in School B languages participants that makes an explicit reference to reconceptualisation with respect to a concept typically found in technology participant responses; 'creative / creativity'. This does not suggest that languages are not creative endeavours. P1 is considered important in this context given the stimulus material provided to participants. P1 appears as a statement of meaning within the expected

overall response of a concept map with hierarchical relationships clearly indicated. P2 supports P1 by providing an explanation of how such 'creativity' may manifest itself in tangible outcomes such as poetry and creative writing. P3 is connected to P2 and references the layering of skills as a 'hand in hand' relationship to P2. As previously discussed, this does not suggest that languages ability is not considered a skill. Rather, that the participant has considered creativity in another subject context and applied that to languages. In addition, the participant has expressed the desire to explore new 'skills' in language development.

Follow-up interviews

Due to scheduling constraints, School B Phase 2 follow-up interviews were conducted in mixed groups of technology and languages participants (see also Appendix J). In follow-up interviews, languages participants provided further explanation of how they were impacted by Phase 1 technology participant propositions. Propositions in Phase 2 follow-up interviews are tabulated in Appendix L, with selected *languages participant* examples presented in Table 57 below.

Table 57 Propositions, School B, Phase 2, Follow-up interviews, Languages

School B Propositions Follow-up Interviews, Phase 2 Identified in the Raw Data	
Theme	**Proposition**
Insight	1. I think for me it's been quite a big change and I think I've been influenced by what they've been writing, because I think in the last one, I talked a lot about understanding, but now I'm talking more about learning the skills.... I think, yeah, I've been influenced by what the technology students have written. 2. I think I looked a lot closer at the solving and creativity aspects, because before I just talked about understanding and how that can lead to opportunities... 3. ...I talked a bit about connections, but I didn't really think about the solving and creative aspects and how that links together, and then how that links back to the understanding of the language. 4. Because in my first one [concept map] I didn't really think too much about the creative aspect of it, but now after seeing what the technology students brought up, I was like, oh yeah, I like that idea.

School B Propositions Follow-up Interviews, Phase 2 Identified in the Raw Data	
Theme	**Proposition**
Connection / Linking	5. Whilst in other subjects like DT, you sort of have to use the other part of your creative mind in which to...You make something that's new, that's not been brought up to you before....Whilst in language, you have to use the ones that have been brought up to you before, the ideas that have been brought to you before. 6. With the creative subjects like English, Art, and DT, there's more of an open playing field in which there's so many ideas that you could come up with but in Indonesian and other languages you've kind of got the smaller playing field with words you've got to learn and you've kind of got to just focus on that area first before you really expand. 7. My old one [concept map] didn't really have many connections between the things, and it was more streamlined, but now it's sort of more connections and things might have multiple things on them, because a lot of things can be applied to other things in Indonesian.

Languages participant propositions shown in Table 57 provide the most elaborate and strongest evidence of impact imparted by Phase 1 technology participant propositions. The propositions in the table are numbered for ease of reference.

Languages participants express deep reflection in their responses with language of high conviction. The proposition 'I think for me it's been quite a big change and I think I've been influenced by what they've been writing' (1) provides insight into the impact of the Phase 1/2 experience. In Phase 1, the participant was focussed mostly on 'understanding' which is a key theme across School B. However, the participant has reconsidered their study in terms of 'skills' which is a common thread across technology participants at Schools A, B, and C. The participant closes with 'I think, yeah, I've been influenced by what the technology students have written'. The participant does not indicate that 'understanding' has been replaced by 'skills'. The implication is that 'skills' as a concept has been added to the conceptualisation. Other participants considered concepts such as 'solving' and 'creativity aspects' (2) more closely, and others mentioned them but then conceded that they weren't influenced by them (3). In contrast, one response indicated the consideration of creative factors (typically associated with design and technology subjects) in Phase 1, but that they did not include them in conceptualisation (4). Yet, when prompted by revised focus questions in Phase 2, the participant's perception changed with the response of 'oh yeah, I like that idea'.

The theme of 'connection / linking' was associated with languages participant responses as participants created more explicit relationships between specific subjects. Reflections such as 'whilst in other subjects like DT', and 'whilst in language' (5), illustrate the process of comparison that participants worked through. A noteworthy distinction was made in that 'with

creative subjects like English, Art, and DT, there's more of an open playing field in which there's so many ideas' (6). However, the same participant expresses that 'in Indonesian and other languages you've kind of got the smaller playing field with words you've got to learn, and you've kind of got to just focus on that area first before you really expand' (6). In drawing conclusions about other subject areas, the participant has identified limitations to a potentially fuller experience of languages. Similarly, another languages participant reflects that 'my old one [concept map] didn't really have many connections between the things, and it was more streamlined, but now it's sort of more connections and things might have multiple things on them' (7).

School B Phase 2 follow-up interviews provide an example of additional insight that can be gleaned from participants after the concept mapping exercise. Whilst technology participants did not offer propositions describing complementary value, languages participants demonstrated the capability to deeply reflect upon and include aspects of technology propositions in their conceptualisation of languages study. It is reiterated that languages participants produced a greater volume of propositions in Phase 2 than Phase 1 overall, and that these propositions mostly referred to the value of languages and languages learning. However, the presence and content of the above comments in follow-up interviews suggests that there is complementary value between languages and technology subjects for those participants. It cannot be assumed that this result would occur for all languages students in any context. Yet the possibility of such an outcome, as demonstrated in this example, has implications for teachers which will be addressed in the discussion chapter.

Findings presented in this section reveal that complementary value propositions between technology and languages subjects exist for School B participants. There was little evidence of complementarity in conceptualisation, although minor indications of re-conceptualisation did occur. Both technology and languages participants appeared to describe complementary value more readily in proposition statements made on concept maps and (for languages participants) follow-up interviews. Both groups were also able to offer suggestions on how they would imagine those propositions would become tangible. Designing for others' needs and designing to bring people closer together with greater awareness of factors such as equality, ethics, consumerism, and material selection, are examples of the possibilities considered by technology participants. Similarly for languages participants, complementary value propositions were not nebulous, but resulted in clear desire to apply 'creativity' to languages to produce artefacts such as poetry and creative writing. Clearer connections between other subjects could be drawn and limitations of current language learning were identified. The presence and nature of complementary value propositions in School B Phase 2 responses suggests further potential in this exercise which will be addressed in the discussion chapter.

To assist the reader, high-level findings of this sub-section are summarised in Table 58 below.

Table 58 Section 4.4.2 High-level summary

Research Question 3 Section 4.4.2 School B - Relationships and Complementary Value		
Complementary Value	**Technology Participants**	**Languages Participants**
Found in...	**Themes of:** • Value perception • Understanding • Connection • Learning • Reasoning	**Themes of:** • Insight • Connection / Linking
Expressed in/as...	**Propositions communicating:** • Benefit to people • Understanding of society and human factors • Bringing people closer • Benefit to cognitive function • Greater awareness of other perspectives. The above communicated primarily through concept maps.	**Propositions communicating:** • Increased identification of languages as a 'skill'. • Languages as a creative endeavour. • Limitations of languages learning when compared with other subjects. • Recognising connections with other subjects. • Languages as a problem-solving activity The above communicated through concept maps and follow-up interviews.

4.4.3 School C – relationships and complementary value

School C participants created Phase 2 concept maps from revised focus questions containing propositions from Phase 1 participants at Schools A, B and C. As noted in Section 4.4, School C participants produced additional propositions in Phase 1 data collection which were added to those from Schools A and B.

Conceptualisation

School C technology and languages participants produced a greater volume of concepts in Phase 2. Languages participants produced materially more concepts, whereas the increase for technology participants was minor. Table 59 below recaps School C Phase 2 conceptualisation.

Table 59 Concepts, Phase 2, School C, Technology & Languages

Themes	School C – Concepts Identified in the Raw Data Technology Students Phase 2	School C Concepts Identified in the Raw Data Languages Students Phase 2	Themes
Learning	Learn Learning abilities fun to learn Memory / Perception Understanding	Learn new skills. learn ask (technology) skills / techniques know Improve skills, memorisation, comprehension, reading/writing	**Learning**
Technology discipline	investing in new technologies	confidence (language) learn new perspectives (language) literacy	**Languages**
Connection	Deep connection to technologies Communication Time Connection	encountering cultures make connections. communication / expression communicate (language) Others	**Connection**
Motivation / Aspiration	Helping others Expression	Improvements Improve / make better. Change Change, the world (technology) Helping others express the world interested experience	**Motivation / Aspiration**
This cell is left intentionally blank.		future focus lifestyle (change of) jobs travel interests To grow (language) Future, person, and society the future.	**Value Perception**
		to design creativity to solve problems creativity (technology) to design (technology) To make / build. Solve problems. Make, build, design, solve, Improve	**Design / Create**
		Food Cuisine Culture Wisdom Explore culture.	**Culture**
		Wisdom Use logic Logic Similarities, new skills, logic, improve. Differences, to make, solve, be creative.	**Insight**

Table 39 is superimposed with red lines/arrows, and two regions indicated by red rectangles to indicate where complementarity of concepts was identified. It is reiterated that there were only two technology participants at School C which contributed to a lesser quantity of concepts identified. Despite the lesser quantity, there is evidence that technology participants were influenced by revised focus questions. The concepts of 'helping others', 'expression', and 'connection' appear for technology participants alongside similar concepts recorded by languages participants, as shown in Table 59 by the red arrow. Themes of 'connection' and 'motivation / aspiration' were absent from Phase 1 technology participant responses. The appearance of these themes in Phase 2 may simply be due to being prompted by Phase 2 focus questions, however their presence does indicate some impact.

Languages participants' responses revealed a stronger impact from revised Phase 2 focus questions. Themes of 'design / create' and 'insight' became apparent, with clear references to concepts more commonly associated with design and technology subjects such as 'to make/build', 'solve problems', 'use logic', '[acquire] new skills', and 'be creative'. These findings are similar in nature to those for School B languages participants who also demonstrated a stronger reconceptualisation in Phase 2 than did School B technology participants. It is not suggested that similar outcomes in two schools amongst languages participants represents a pattern, however the similarities are noteworthy. Closer examination of propositions in concept maps is required to determine the extent of the presence of complementary value.

Complementary Value

School C technology participants produced propositions which did not indicate a strong influence from revised focus questions in Phase 2. Themes of 'reasoning' and 'connection' were revealed in the propositions listed, although at face value the evidence of complementary value between technology and languages subjects is tenuous. Propositions within the theme of reasoning include,

- Tech is everywhere, even in languages.
- Life lies ahead.
- How technology can make the world a better place.

The above propositions provide evidence that there was some consideration of factors present in revised focus questions, however it is difficult to determine the extent to which these propositions are meaningful to the participant. In contrast, one proposition listed was identified within the theme of 'connection' and reveals a deeper reflection on languages participants' propositions. Figure 48 below illustrates the concept map in which elements are illustrated in a tightly integrated manner between languages and technology.

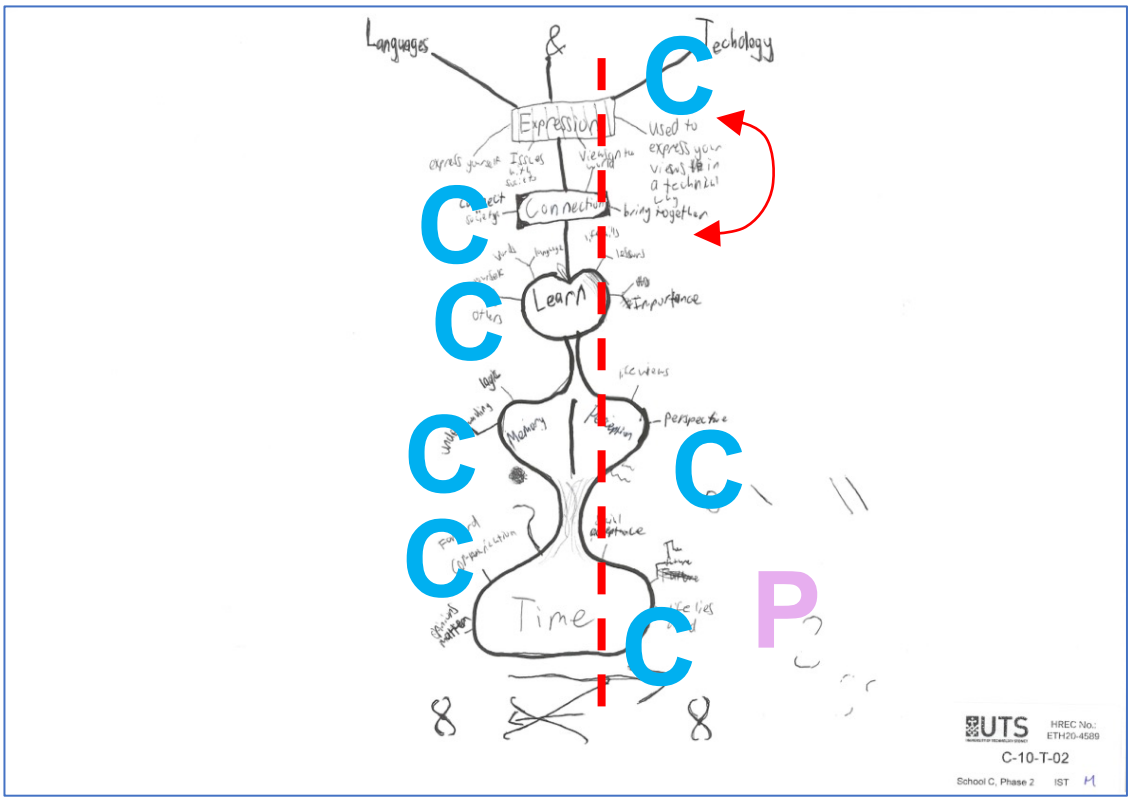


Figure 48

Figure 48 is superimposed with labels ‘C’ (concept), ‘P’ (proposition), a red dashed line to indicate a central axis, and a red line/arrow to indicate the ‘relationship’ between connected elements. This example is pertinent because it illustrates that the participant has reconsidered the concept mapping task in a unique manner. It also demonstrates insight into how the participant has reimagined not only technology, but perhaps also languages as the two appear to be stated with even importance. The central axis divides the overall image with elements appearing evenly weighted on either side. At first glance, the text adjacent to the red line/arrow could be construed as a proposition. It reads, ‘used to express your views in a technical way’. However, in the context of its location it appears more as a relationship between the concepts of ‘expression’ and ‘connection’. This also appears typical of other text elements appearing on the concept map suggesting that this participant has produced a concept map mostly of concepts and relationships, without a strong presence of written propositions. One proposition was identified as ‘life lies ahead’, which could be intended to illustrate the elements above contributing to the preparation for future life. In this case, the identification of propositions is more difficult when compared with other examples presented in this chapter. However, at higher level, the overall morphology of symmetry in this response indicates a deep consideration of the potential that lies between languages and technology subjects. The symmetry along the central vertical axis could therefore be interpreted as a visual proposition where the participant perceives the potential to interconnect or link the subjects.

School C languages participants produced propositions revealing evidence of influence by revised Phase 2 focus questions. The theme of ‘create/make’ was identified with propositions including,

- To improve and make better.
- To be creative
- To learn and make new skills and techniques.
- To design
- To make and build with new skills and techniques, learn new skills.

Similar responses to those above were found in School B languages participant concept maps. Noteworthy in this context is that School C languages participants also reframed languages learning in terminology more typical of technology subjects. As with School B, this does not suggest that languages ability is not considered a skill. However, the terminology used indicates that languages participants considered a different perspective.

The theme of ‘reasoning’ was strongly represented in School C Phase 2 languages participant responses. Within this theme, several propositions indicate an awareness of complementary value, including,

- Tech is somewhat seen in building the ability to communicate.
- Both types of students use logic to overcome challenges.
- Both STEM and languages help students in other areas of school with comprehension and memorisation.
- Use logic to overcome challenges.

The propositions listed above communicate complementary value between languages and technology and value that can be experienced in wider subjects. Both subject areas are seen as building capability for problem solving using logic, cognitive function (memory) and literacy skills (comprehension). In contrast to other examples presented, these propositions feature prominently in Figure 49 below which contains less morphological structure.

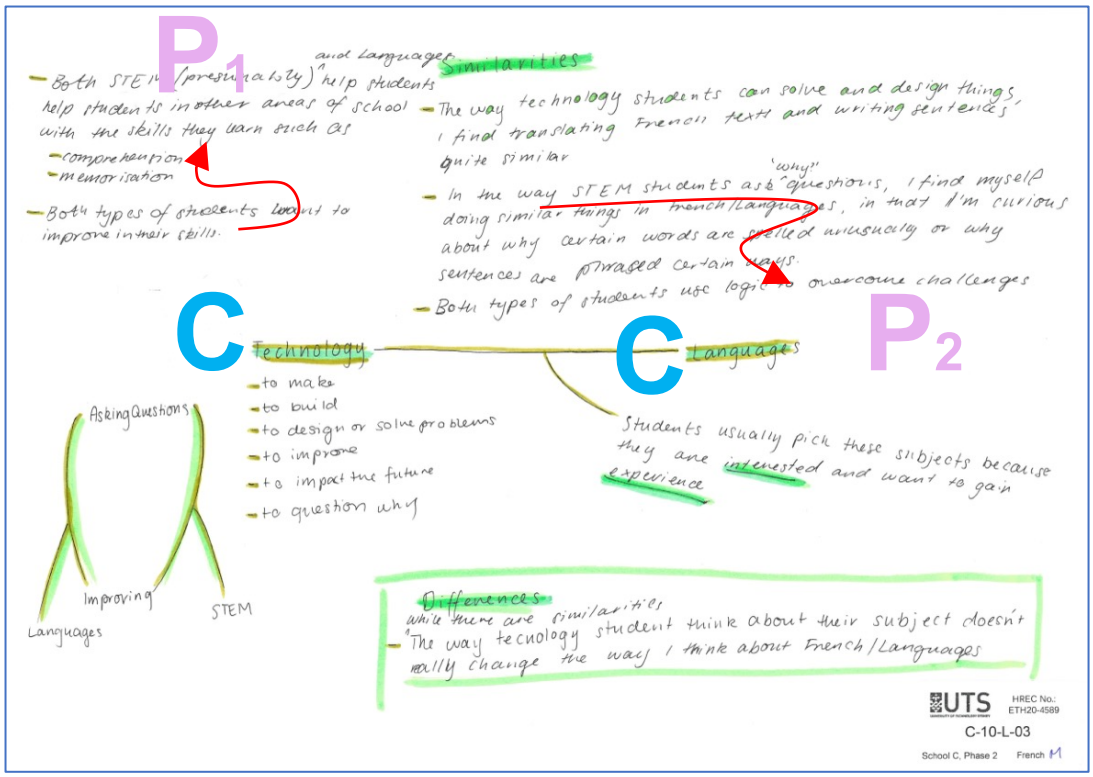


Figure 49

Figure 49 is labelled with 'C' (concepts), 'P' (propositions) and red lines/arrows indicating 'relationships' between connected elements. This concept map is an example which demonstrates a preference for listing proposition statements with less focus on hierarchical structure or graphical elements. The propositions shown are found within text which also contains relationships statements (red lines/arrows). Despite the text being separated by 'points', relationships appeared to flow between the statements arriving at propositions. With respect to P1, the statement of 'both types of students want to improve in their skills' was seen in relationship with the points immediately above of, 'comprehension' and 'memorisation'. Together, these relationships arrived at the proposition (P1) that 'both STEM and languages help students in other areas of school'. In a similar manner, the statements leading to P2 indicate that the participant is comparing the processes by which challenges are overcome. The participant reflects that 'in the same way STEM students ask why questions, I find myself doing similar things in French/languages' (a relationship), whereby 'both types of students use logic to overcome challenges'. Logic is not seen as unique to STEM (or technology) in problem solving and can be applied more widely. The use of logic in this way may be considered universally acceptable, however the point of interest in this case is that the participant has made this connection explicitly. This suggests a connection has been made or strengthened. Whilst there is little use of graphical elements, Figure 49 also demonstrates a structured (or logical) approach in reaching the proposition statements shown. A compare/contrast method is used in that 'similarities' and 'differences' are clearly labelled and considered. This supports the use of freedom in concept mapping in this study, as with Holmlund et al. (2018), in that the participant

was able to communicate propositions in a manner perhaps not possible through more graphical means.

In contrast to Figure 49 above, Figure 50 below illustrates a languages participant response which uses less written statements and relies mostly on graphical representation.

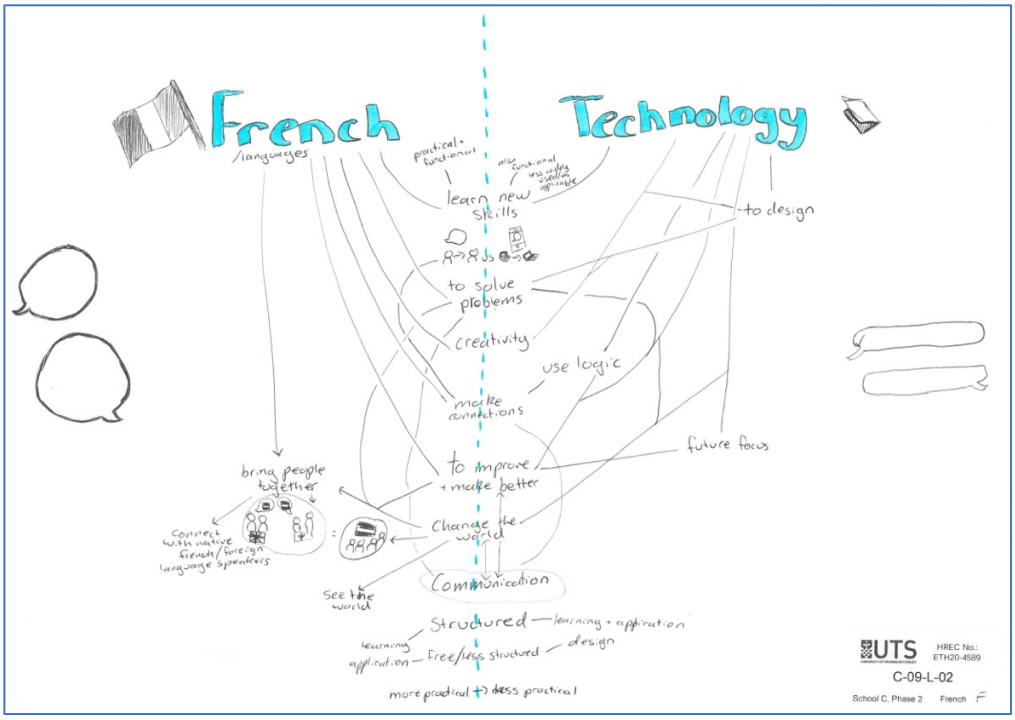


Figure 50

Similar to the technology participant response in Figure 48, the participant uses a symmetrical approach with elements evenly represented between French(languages) and Technology. The response does not appear to favour either domain. Rather, the image presents potential in viewing the two subjects as interconnected or linked, again through the representation of a central axis. There is little evidence in this concept map that the notion of complementarity has been rejected or does not exist for this participant.

Follow-up interviews

School C follow-up interviews revealed evidence of data saturation as less audio was recorded and participants began to show visible signs of exhaustion (see also Appendix K). Interviews were conducted immediately following the concept map creation session and included languages participants and the two technology participants. Despite more limited input, several propositions indicating complementary value were identified. These were flagged in Section 4.3.3 and are discussed further here. The propositions were identified within the theme of 'learning', shown in Table 60 below. Propositions are numbered for ease of reference.

Table 60 Propositions, School C, Follow-up interviews, Technology & Languages

Phase 2 Propositions – School C, Follow-up Interviews Technology and Languages Participants Emerging in the Raw Data	
Theme	**Proposition**
Learning	1. If we are on a Zoom call for example with a German class learning engineering and they could then explore different symbols or different ways that they identify certain things that I think will be interesting. 2. But I feel like a lot of skills that you would learn in either subject could be applied and vice versa. 3. In French it feels like you think very differently compared to other subjects and I couldn't quite figure out the right words to express that. 4. You have to relate everything back and you've got connect things and build upon them in a different way then let's say math, where we'll go there's one thing, now you learn a different thing.

Though few, the propositions indicate an awareness of complementary value. The reference to learning with a German class (1) is in the context of connecting with a school internationally, revealing that the participant's perspective is potentially being stretched beyond the local context to consider wider possibilities. Comparisons between subjects (2), and more specifically French (3) demonstrate that participants were able to continue linking elements of value as they considered the two-way 'vice-versa' relationship between technology and languages. The reference to mathematics (4) reveals an awareness that is less clear, however it appears that the participant was making an effort to resolve the relationships by speaking them out. Whilst not a clear relationship between technology and languages, the effort to resolve the relationships suggests that the participant did not reject the notion that complementary value could be present. There were no clear references in follow-up interviews by technology participants with respect to complementary value.

Findings presented in this section revealed that complementary value propositions between technology and languages subjects exist for School C participants. Despite fewer technology participants, complementarity was found in both conceptualisation and value perception. Similar to School B, languages participant propositions were more readily represented as complete statements on concept maps, albeit with a focus on logic and skills acquisition. School C participants did not appear to provide further depth with respect to tangible outcomes of complementary value in the manner that School B languages participants were able. However, the propositions offered suggest that the extent to which complementarity is perceived is clearly present and meaningful. Propositions expressing complementary value were unambiguous, and concept maps using symmetrical structure presented compelling visualisation of potential integration between technology and languages. The extent of complementary value revealed in School C responses has implications for teachers which will be addressed in the discussion chapter.

To assist the reader, high-level findings of this sub-section are summarised in Table 61 below.

Table 61 Section 4.4.3 High-level Summary

Research Question 3 Section 4.4.3 School C - Relationships and Complementary Value		
Complementary Value	**Technology Participants**	**Languages Participants**
Found in...	**Themes of:** • Connection • Motivation / Aspiration	**Themes of:** • Design / Create • Insight
Expressed in/as...	**Propositions communicating:** • Communication • Helping Others • Expression The above communicated primarily through concept maps.	**Propositions communicating:** • To make / build • To create...be creative • To solve problems • Use logic. The above communicated through concept maps and follow-up interviews.

4.4.4 Relationships and complementary value – Schools A, B, and C

This section consolidates findings documented in Chapter Sections 4.4.1, 4.4.2, 4.4.3, and addresses **Research Question 3**.

> To what extent are there complimentary value propositions between languages and technology subjects, and how do students express this?

Key statements are highlighted in Boxes 21, 22, and 23 to simplify the density of findings for ease of readability with respect to the research question. These key statements are referred to as the basis for discussion of conceptualisation in Section 5.4.

Findings presented in Sections 4.4.1, 4.4.2, and 4.4.3 reveal that participants across Schools A, B, and C were able to identify and express complementarity between languages and technology subjects within the context of the study. The Phase 1 / 2 nature of the study was required to enable participants to respond to value propositions presented by alternate groups: technology and languages students. In addressing RQ3, determining the extent to which complementary value propositions are present did not involve an experimental process. There was no control group. Rather, RQ3 was aimed at reflections by participants on their personal conceptualisation, perception of value and lived experience of the subjects they were studying. As such, no corroboration of responses or examination by interrater was required during the analysis. The concept map method allowed participants to visualise how they see themselves in this experience and then express themselves in concept maps using images and visual means

(Kendrick & McKay, 2002). As noted in Chapter 3 Methodology, it is possible to participate in an activity, endeavour, or society and not theorise about it (Berger & Luckmann, 1966). The process used in this study provided an opportunity for participants to theorise about their subjects in isolation, and in the context of value expressed by students in another subject. Understanding perceptions of value held by participants studying subjects at the margin (or in subjects of declining enrolment) can help identify opportunities to explore new value based on previously unknown or unconsidered value (Christensen, 2013). Since this study does not employ experimental techniques, complementarity was not 'measured'. The extent to which complementary value is present between the two subjects is considered on a broader thematic basis, consistent with the method for presenting other findings in previous sections. This also provides insight into how students express complementary value and how they perceive mutual benefit between the subjects.

> Participants were able to identify and express complementarity between subjects when presented with conceptualisation and value perceptions from participants studying other subjects.

Box 21

It is important to reiterate that participants were not asked in Phase 2 focus questions to respond specifically to a question related to complementary value. Phase 2 focus questions were stated as,

- *If you were to consider those as propositions **to you** for your subject, how might you re-conceptualise your subject?*
- *What else might you consider?*

Therefore, any evidence of complementarity emerged from within the data within Phase 2. As found in previous sections, conceptualisation across Schools A, B, and C remained relatively stable with only minor changes in concepts and themes generated. Phase 2 complementary value was mostly seen in stated propositions. In broad terms, technology participants began to see complementary value in becoming more aware of people, society, and the impacts of technological or design outputs on the world around them. Languages participants appeared to place greater emphasis on languages ability as a skill and recognise further potential for using languages to overcome challenges in logical and creative ways.

Technology participants expressed a greater awareness for the potential of technology to help people or become more attuned to the human factors involved with developing technological solutions. In this case, 'technology' refers to the experiences typically involved with technology and design subjects within a school context. It does not refer to technology as a term broadly applied to any skill, artefact or tool that can be used to achieve any particular purpose. Propositions that resonate across the three schools include,

- Better understanding of others (School A)
- Building high quality things for people rather than corporations (School A)
- Learn how to help others (School A)
- Humanitarian side of engineering (School A)
- Benefits people around you (School B)
- Increase understanding between us (society) and the environment (materials, consumerism, ethics, habits & change, equality). (School B, teacher response)
- Understanding people's reasoning for doing something that way. (School B)
- Through tech we can design and create new things that bring people closer (School B)
- Life lies ahead. (School C)
- How technology can make the world a better place. (School C)

At face value, the above propositions could be considered to fall within an expected range of responses in the context of a subject that designs solutions to problems and has a future focus. However participant responses do convey a sense that participants have developed a greater awareness of the impacts of technological solutions, products, and outcomes on the needs of individuals in Phase 2. Moreover, that participants are more sensitive to understanding others' needs, and how they can be helped, which was less evident in Phase 1. It is recognised that

> Technology participants expressed complementarity between technology and languages through awareness of people, society, and the impacts of technological outputs on the world around them.

Box 22

propositions such as those outlined above are similar to those addressed in Section 4.3 which examines perceived value and motivation for subject selection. The key difference in this section is that those propositions listed above here, appear to have the greatest influence from exposure to languages participant value propositions. Whilst subtle in the data, it is suggested that there is enough influence to create implications for teachers. These will be discussed further in the discussion chapter.

Languages participants at Schools B and C (there were no languages participants at School A) produced propositions indicating a greater awareness of designing, creating, the acquisition of skills, and the use of logic. As previously stated, the findings are not considered to suggest a new association between languages and a 'skill'. Notable in these findings is the increase in use of language of 'skills' and 'developing skills' that was not evident in Phase 1 responses for these participants in this context. Phase 2 languages participant responses indicating this increase include,

- I would reconceptualise languages in the sense that I would want to learn how to be creative in this language...I'd probably want to learn how to do things like poetry/creative writing like we do in English class. (School B)

- I looked a lot closer at the solving and creativity aspects...(School B)
- Whilst in other subjects like DT, you sort of have to use the other part of your creative mind in which to...You make something that's new, that's not been brought up to you before....Whilst in language, you have to use the ones that have been brought up to you before, the ideas that have been brought to you before. (School B)
- Both types of students use logic to overcome challenges (School C)
- Both STEM and languages help students in other areas of school with the skills they want... (School C)

Noteworthy in this context is the shift in language used by participants in concept map responses and follow-up interviews, whereby the above propositions became evident in Phase 2 after exposure to Phase 1 technology participant responses. This is similar to the subtle appearance of new language to describe complementary value for technology participants. A potential outcome for participants is that reciprocal value could be gained between the two groups if they were afforded the opportunity to share such value during their study.

> Languages participants expressed complementarity between languages and technology by emphasising languages as a 'skill' providing the potential to overcome challenges in logical and creative ways.

Box 23

The indications of complementary value by technology and languages participants presented in the previous sections range from subtle to unambiguous. Observation of findings in this section are not considered to be sufficient to draw conclusive statements about complementarity. However, the extent to which complementary value is presented by participants across Schools A, B, and C is considered enough to create meaningful implications for teachers. These will be considered in detail and with further reference to associated literature in the discussion chapter.

CHAPTER 5: Discussion

5.1 Chapter Structure

Findings in this research study addressed three research questions and are reported on under the following chapter section headings:

4.2 Conceptualisation – Research Question 1
4.3 Proposition and Value Perception – Research Question 2
4.4 Relationships and Complementary Value – Research Question 3

In answer to the research questions, each of the sections above resulted in high-level findings statements that addressed the research question. These statements form the basis of discussion in this chapter. For consistency, and to assist the reader, the following three sections discuss implications of the findings through the lens of the conceptual frame outlined in Chapter 2.11. The statements are considered in terms of conceptualisation and the disruptive innovation frame. It is acknowledged that not all the Research Parallels drawn from the theory of disruptive innovation may apply throughout the discussion. The discussion does not seek to find a disruptive technology to 'fix' the dilemma stated in this research study across all schools. As stated in Chapter 3.6.3 Generalisability, the findings in this study are not considered to be broadly generalisable as the participant responses at the three research sites are considered unique to those sites. It is acknowledged that not all students in all schools would respond in the same way as those participants in this study. However, the unique nature of the data could inform practice at those schools locally, and insight into student conceptualisation and value perception gained could be shared between teachers at other schools. Therefore, the discussion presented in the following sections aims to identify opportunities for 'disruptive thinking' for improved decision making and strategy to address the dilemma.

5.2 Conceptualisation – Research Question 1

High-level findings statements were identified that broadly addressed Research Question 1 (RQ1).

Research Question 1 (RQ1)

- How do students conceptualise Technology and Languages subjects they study, independently from notions of assessment or curriculum?

High-level statements addressing RQ1, found in Boxes 6 to 10, Chapter 4.2.5:

1. Participants were able to conceptualise their subjects after being prompted by focus questions designed to address the research questions.
2. Participants conceptualise their subjects as a place of learning.
3. Participants perceive value in their subjects: for themselves in the present through new learning; for themselves in the future through employment opportunities; for themselves in the future for lifestyle benefits.
4. Participants possess and express the ability to reason and make judgements about the subjects they study.
5. Participants can consider other students' conceptualisations of other subjects, and how that may influence their conceptualisation of their own subjects.

The following sub-sections discuss these statements with respect to the literature and conceptual frame.

5.2.1 Innovation was not broadly conceptualised by students

The discussion begins with this noteworthy observation. Despite the literature indicating that the need for 'innovation' is clear and present (Bocconi et al., 2013; Bower, 2020; OECD Centre for Educational Research and Innovation (CERI), 2008; Shalberg, 2011), a conceptualisation of, or for, innovation remains absent in participant responses, with the exception of two School B technology participant responses. As stated in Chapter 1 Introduction, 'innovation' is implied in the Australian Curriculum rationale with notions of 'new', 'develop capacity for action', and 'opportunity' (ACARA, 2024d, Rationale, para. 4). Participant responses did reflect those notions, however they were not interpreted or labelled by participants as a presence of innovation within their subjects.

Focus questions provided to participants did not specifically request students to respond to a notion of innovation, nor did they prohibit it. The notion of innovation simply did not appear in the data as a key component of how participants conceptualise their subjects independent of any frame of curriculum, or assessment of knowledge. Given commentary such as the world-wide scale with which innovation is considered in education contexts (We et al., 2017), the burden placed on technology/STEM disciplines to address problems "in times of global vulnerability" (ICASE, 2013, p. 1) and the rationale for languages which stresses the need to "negotiate experiences and meanings across languages and cultures" (ACARA, 2024c, Rationale, para. 3), an expression of the need for innovation remains rare (almost absent) in participants. In the context of addressing RQ1 participants do not conceptualise their subjects as innovative per se.

The observation above does not suggest that participants were in classes where innovative practices were not being utilised. However, it could indicate that if classes were perceived by teachers as innovative, the participants were not aware of it. This potentially raises the question of whether students need to be involved in the innovation process for innovations in education to take hold. Alternatively, it raises the question of whether innovation should be driven by the authors of curriculum and policy, or more heavily influenced by an understanding of student perception. For establishing an understanding of how students conceptualise their subjects could influence approaches to innovation. It is acknowledged that this line of argument can quickly become cyclical with no practical or workable outcome. Therefore, the discussion continues with the conceptualisation of 'learning' as a theme, which is strongly represented in the data and forms a more useful starting point. The conceptualisation of 'learning' is both expected and, to a degree, counterintuitive.

5.2.2 Learning as practical student involvement

The theme of learning is clearly identifiable through the conceptual frame. The process of moving from conceptualisation to proposition, and value perception placed participants at the centre of knowledge and skill acquisition through words and statements made on concept maps including;

- Teacher to class session (School A, Technology, Phase 1)
- Learn by doing (stuff) (School A, Technology, Phase 1)
- Teacher to class learning (School B, Technology Phase 1)
- Applying learning (School B, Technology, Phase 2)
- Ability to learn (School B, Languages, Phase 2)
- Way of learning (School C, Languages, Phase 1)

Participant responses appear to recognise both the student and teacher's role in the learning process. With respect to the actual task or process of learning, there is no evidence in the data that participants perceived themselves simply as recipients of content. The components of 'learning' stated above indicate that participants perceive themselves as part of a process and that they have an expectation for it. This is counterintuitive to a degree, as it indicates a latent motivation to learn. For if there is motivation to learn, then facilitating learning could potentially lessen the need for innovation. A lesser need for innovation calls into question the manner in which learning is facilitated which is a dynamic seen in the study by Wilson (2020).

In the Wilson (2020) study, the motivation to learn was present in students, however, attempts to 'innovate' fell short of student expectations. As previously noted in Chapter 2.10, Wilson (2020) acknowledges the difficulty of implementing a "disruptive pedagogy when there is a broader, long standing and accepted view of what successful teaching looks like" (p. 12). Yet as

discussed, the model implemented by Wilson was not strictly a disruptive innovation as students were already in classes and learning. That is, the alternative of no classes (or nonconsumption) did not threaten students' ability to participate. In the context of findings reported in this thesis, the presence of an underlying motivation to learn, and a recognition by participants of being a part of the learning process is noteworthy. It is an important first step into recognising 'disruptive thinking' for effective strategy. The first principle of disruption is that "companies depend on customers and investors for resources" (Christensen, 2013, p. xix). Research Parallel 1 resonates in this context in that schools and subjects depend on students for funding and survival. In this research context, students are present and conceptualise themselves as participating in learning. Whilst seemingly obvious, the recognition of present learners is a counterintuitive step towards addressing the dilemma of low participation and performance. Disruptive thinking is not concerned with 'improvement' thinking. Rather, it is concerned with 'alternate' thinking. An application of this principle with respect to this research finding is not to focus on the low numbers and perceive them as a problem. Rather, to focus on the fact that there *are* numbers and uncover ways to leverage them. Wilson (2020) noted the difficulty in competing against long standing successful teaching methods. In contrast, the disruptive educator in this research context may pause to think less about competing with high participation numbers in other subjects, and more about adjusting the experiences of current students within their own subjects.

An insight into where the adjustment of student experience may begin is offered by the practical way in which participants perceived their involvement. 'Involvement' was evident in theory and practice, indicating again that participants did not perceive themselves to be recipients of content but actively engaged in it. Learning theme components of 'learn by doing', 'applying learning', and 'learning abilities' speak to expectation of tangible, practical involvement that participants expressed. The practical nature of these components was commonly cited by technology participants. It is acknowledged that these may be more readily associated with traditionally practical subjects such as technology. However, the notion was shared by languages participants in Phase 2 responses in learning theme components including,

- Learn new skills (School C, Languages, Phase 2)
- Skills / techniques (School C, Languages, Phase 2)
- Improve skills (School C, Languages, Phase 2)

Notably, the above three components for School C participants were recorded by participants after having been exposed to propositions recorded by technology participants. This potentially indicates a shift in perception of languages participants and a widening expectation of their learning outcomes in languages study.

5.2.3 Conceptualisation of value

Findings outlined in Chapter 4.2.5 identified six themes which occurred with noticeably greater concentration in the data. These included,

- Learning
- School subject
- Value perception
- Create / Make / Design
- Culture
- Reasoning

The themes of learning, value perception, and reasoning were highlighted as they were less anticipated. When considered through the conceptual frame outlined in Chapter 2.11, the notion of value becoming evident in 'conceptualisation' sheds light on the importance of value perceived by participants. Whereas participants were not prompted to respond to 'innovation' in focus questions, the notion of value was examined through the second focus question. Both focus questions for Phase 1 data collection are stated again here for reference.

Phase 1

- How do you conceptualise STEM / Technology Education / Languages?
- What factors influenced your sense of value in making this subject selection?

The presence of a conceptualisation of value in participant responses presents an important implication for educators. Participants were instructed to respond to the above focus questions individually, and independent of any notion of curriculum, assessment, or their performance within the subjects. Nowhere in the data did a conceptualisation of 'no value' occur. In some cases, there were expressions of disappointment at the lack of 'expected value', and this will be explored further in Chapter 5.3 where value proposition and motivation are discussed. However, from a purely conceptual basis, the teachers of these participants are supported by an underlying awareness of value in the subjects held by the participants (students) themselves. Findings also indicate that the awareness is equally present in technology and languages participants.

This finding, although basic, highlights that participant conceptualisation in this study is broadly aligned with overarching statements made by policymakers and commentators about the importance of technology and languages study. As students progress through the technologies curriculum, the Australian Curriculum Assessment and Reporting Authority (ACARA) states that students "will begin to identify possible and probable futures, and their preferences for the future" (ACARA, 2024a, para. 2). Similarly for languages, ACARA states that "the interdependence of countries and communities means people in all spheres of life are required

to negotiate experiences and meanings across languages and cultures" (ACARA, 2024c, Rationale, para. 3). It is against this backdrop that participants in the study responded to focus questions with value themed conceptualisations of,

- Future careers (School A, Technology, Phase 1)
- Global impact (School A, Technology, Phase 1)
- Future jobs (School B, Technology, Phase 1)
- Future / skills (School B, Languages, Phase 2)
- Gain life experience (School C, Languages, Phase 1)
- Future focus (School C, Languages, Phase 2)
- Future; person and society (School C, Languages, Phase 2)

At face value, such a conceptualisation could suggest that educators do not face competition with students when attempting to facilitate learning as students find the subjects inherently valuable. Attention is drawn again to the point that participants were required to consider their subjects on their own terms, and not in terms of their understanding of curriculum or policy. Given the alignment identified above, the extent to which any kind of reform may be needed to address participation in technology and languages could be less than anticipated.

The introduction to this thesis places this research study in the context of reform. Whilst reform is not being investigated, it cannot be ignored as it may be considered to have been taking place during the study. Discussion surrounding the definitions of STEM education in Chapter 1.1.1 and the development of a local STEM curriculum in Chapter 2.1 illustrate the constant nature in which curriculum is being 'reformed' or reinterpreted. At the time of writing, students at School A are now studying a revised version of the STEM syllabus that participants at School A were studying during data collection (see Chapter 2.1). However, it has been argued that reform is not limited to curriculum specifically such as a change or modification to a syllabus as in the case of School A technology participants. Gilbert (2010) cites Kliebard (2002) who argues for the interconnectedness of curriculum and pedagogy in 'reform', but then also notes that curriculum reform can be "more commonly used to describe the general process of curriculum change or development at a system level" (Gilbert, 2010, p. 510). The continuous reinterpretation of curriculum can lead to what Gilbert describes as

> curriculum decisions [involving] value judgements about the purpose of schooling and the most valued forms of knowledge, and how they are related to the cultural practices of different social projects and interests.
> (Gilbert, 2010, p. 510)

The consideration of 'reform' discussed here offers insight into the three different research sites (schools) and the forms of knowledge considered important enough to offer to students as elective subjects. Broadly, the rationale of the curriculum and the conceptualisation of subjects

as held by participants consider the subjects to be valuable. Schools also consider the subjects valuable enough to offer to students as elective subjects in addition to the mandatory technology and languages subject requirements in earlier years. However, as previously discussed the elective offerings remain strained. Whilst the connection of value in this finding could be considered highly simplistic, the kernel of knowledge to be recognised is that the complex process of reform is possibly unnecessary to address the dilemma discussed in Chapter 1 Introduction. A notion that remains underrepresented in the literature and is explored further in this discussion (See Chapter 5.3) is the motivation that proceeds from student value perception and how that can be leveraged. As a way forward in addressing the dilemma raised in this thesis, leveraging the value perception would represent a type of 'bottom-up' approach. Rather than focussing on reform or improvement to attract participation, the focus could be on recognising the perception of value presently in currently enrolled participants and facilitating that through practical learning experiences.

When viewed through the underlying principles of disruptive innovation, the above proposition to focus on leveraging value held by participants faces challenges on two fronts. Principle No. 2 states that "small markets don't solve the growth needs of large companies" (Christensen, 2013, p. xxi). Representing this inside a schooling context, schools faced with challenges of growth, or those with a strategy for growth will likely view an effort to grow small cohorts as an undesirable challenge. Research Parallel 2 (RP2) proposes that as mainstream subjects become more popular, schools will be less inclined (or able) to justify assigning resources to growing subjects of lower participation. For schools with growth targets, it would seem more logical to focus on popular subjects with enrolment numbers that are more reliably forecastable. The flipside of this position is reflected in Principle No. 5 whereby "technology supply may not meet demand" (Christensen, 2013, p. xxiii). This translates to research Parallel 5 which proposes that as low demand subjects grow and develop potential to become larger, a strain is placed on popular subjects as competition for staffing and resources increases.

The above situation lies at the heart of the dilemma and echoes a similar dynamic observed by Ramsey and Khan (2020) (see Chapter 2.10). In the small-scale study, which was framed in the context of a dilemma, Ramsey and Khan (2020) noted that developing and implementing innovation in an education context eventually resulted in selling the concept up the managerial hierarchy. Significantly, the 'selling' process involved convincing not only other potential adopters, but also "executives who provide resources and opportunities (Ramsey & Khan, 2020, p. 7) which proved to be a difficult process. It is at this point that disruptive approaches often fail as they are inconsistent with the successful subjects (or products and services) valued by senior management. In a discussion on why computing technology has failed to fundamentally change the nature of schools, Christensen et al. (2010, p. 73) state that organisations will ultimately shape new ideas to fit the "existing organisation's own business model, rather than fitting the market it was intended to serve". This dynamic was also exhibited in the example of

The Ultraversity Project and The IDIBL (Interdisciplinary Inquiry Based Learning) project at a higher education institution examined by Powell et al. (2015) (see Chapter 2.10). Whilst the Ultraversity Project was setup as a disruptive innovation, it was 'ultimately' drawn back into the existing business model of the institution. Christensen et al. (2010, p. 75) state that "organisations *cannot* [original in italics] naturally disrupt themselves" lending weight to schools preferring to support more popular subjects in favour of less popular subjects, even despite the value conceptualised by students enrolled in them. The inability to self-disrupt does not suggest that the technology and languages dilemma examined in this thesis is unsolvable. Rather, it highlights that the pressures faced are echoed in other contexts.

5.2.4 Students engage in reasoning

The theme of 'reasoning' was highlighted in the findings as it was less anticipated at conceptual level and presents implications for educators. Viewed through the 'conceptualisation' component of the conceptual frame, reasoning appears as a step towards propositions that lead to expressions of value perception. Understanding the nature of how students in any given context engage in reasoning can affect the implementation of how subjects are delivered.

In the preceding sections, the discussion identified that participants consider themselves as involved learners, that learning is practical, and that it is valuable. Participants considered this 'practical, involved learning' in terms of local and global contexts, both presently and into the future. At face value, this lends weight to the success of the rationales for both subjects, or at least alignment of the rationales to the conceptualisations of participants in this study. However, at a deeper level, participants indicate that these conceptualisations are not necessarily fixed, or held without ongoing critique. There is a suggestion of fluidity amongst the components of the theme of reasoning including,

- Reason behind building (School B, Technology, Phase 1)
- Critical thinking (School B, Technology, Phase 1)
- Why (did I join)? (School B, Languages, Phase 1)
- Intelligence across subjects (School B, Technology, Phase 2)
- Ask, solve, improve (School C, Languages, Phase 1)
- Aptitude (School C, Technology, Phase 1)
- Gain perspective (School C, Languages, Phase 1)

The implication for the educator in this context is that conceptualisation examined at one point in time may not remain fixed. As participants experience their subjects and engage in reasoning about their experience, it is likely that both conceptualisation and value perception can shift. Whilst such a change may also be seen as an overly simplistic and logical conclusion, the implication is that consequences of ignoring shifting perceptions can lead to negative outcomes.

Negativity became evident through the expression of disappointment through lack of expected value (discussed further in Chapter 5.3). At high level, educators may welcome the engagement in ‘critical thinking’ and the consideration of ‘intelligence across subjects’. However, students may also apply this reasoning and critical thinking to their current experience only to find that their original expectations for value in the subject have not been met.

The dynamic of shifting perceptions is echoed in studies by Kafai et al. (2014) and Conole et al. (2008) as discussed in Chapter 2.10. The Kafai et al. (2014) study examined the two subject areas of e-textiles and computing with participants of similar age to those in this study. The subjects were considered to be disparate and separated by traditional barriers, including the notion that women and girls were historically marginalised or underrepresented in computing. The study deliberately paired the subjects with the intent of ‘disrupting’ traditionally held notions of who could work with computing technology. An outcome of the study revealed that girls did express a shift in perception of their “identities as techies” (Kafai et al., 2014, p. 552) as they, arguably, considered their ‘intelligence across subjects’. ‘Disruption’ is referred to throughout the study, however it is used mainly as a descriptor for breaking down traditional notions about technology subjects as opposed to opportunities for new value.

A more subtle, however no less important shift in perceptions was explored by Conole et al. (2008) in their observation of students experiences of e-learning. Whilst the study only made cursory mention of the disruptive label, a noteworthy finding was made with respect to students’ expectations of communication ‘value’. Of the eight factors influencing students’ use of technology in their learning, the factor of ‘changing work patterns’ is relevant at this juncture. Whereas personal, in-class feedback from tutors might traditionally be considered ideal, students began to consider electronic responses as valuable only if they were quick. It could be argued that participants began to reason that speed was an acceptable substitute for a physical experience. At this point, students in the study could be described as engaging in disruptive thinking as they began to re-rate their perception downwards (though acceptable) of what constituted meaningful communication with their tutors.

When viewed through the disruptive lens, a shift in perception by students as they engage in reasoning about their subjects highlights a challenge of disruption. Principle No. 4 of disruptive innovation states that “an organisation’s capabilities define its disabilities” (Christensen, 2013, p. xxii). The Research Parallel that becomes relevant (RP4) is that a school’s processes and values that enable administrators to allocate resources to one subject hinder its abilities to cater for the resources required by another. Against this backdrop, it can be postulated that the survival of a technology or languages subject requires the value perceptions of its students to remain fixed. This discussion proposes that given the participants’ ability to express reason through the conceptualisations noted above (e.g. critical thinking, the motivation to ask, solve,

improve), schools will struggle to maintain the requirements of curriculum and facilitate demands by participants to vary their experience.

This concept of meeting curriculum requirements and student demands appears again in the findings with respect to motivation and Research Question 2 and is discussed further in Chapter 5.3. The ability/disability dynamic is also echoed in the study by Nowell (2014) discussed in Chapter 2.10, which examined teachers' and students' use of digital and media technologies in an environment where technology device use was institutionally controlled. Driven by pressure to provide equitable access to computing resources, teachers and students turned to cell phones as an alternative to no device. Teachers used devices to develop their work methods and enhance curriculum delivery. However, student device use was self-directed more towards personal, and non-educational purposes. The introduction of a quickly evolving technology (cell phones) added pressure as teachers endeavoured to facilitate their current methods, whilst students quickly found alternative uses. An example of failure in the case described by Nowell (2014) emerged when teachers began to circumvent institutional controls around technology use in the classroom to achieve desired outcomes. In the event that technology and languages participants do engage in reasoning (critical, or otherwise) a risk to the subject is present in that participants are free to switch subject electives. In recognition of RP4 at work, the disruptive educator may choose to embrace student capabilities to engage in reasoning to uncover areas for improved practice or subject (curriculum) interpretation. However, such a strategy could also prove confronting to the educator.

5.2.5 Conceptualisation and reconceptualisation

This research study employed a Phase 1 / Phase 2 data collection method. In Phase 2, technology participants were presented with propositions from languages participants, and vice versa. Participants were asked to consider how they might reconceptualise their subjects in light of the propositions presented to them from the other cohort. As reported in findings Chapter 4.2.5, participants were able to consider other participants' conceptualisations and how they may influence their conceptualisation of their own subjects. New themes were identified in responses of both subject cohorts. This discussion proposes that the reconceptualisation observed is an important example of participant reasoning in practice. The preceding section presented such reasoning as a risk. It is, however, also presented here briefly as an opportunity.

The implications of participants' ability to reconceptualise their subjects is discussed in more detail with respect to complementary value between technology and languages subjects in Chapter 5.4. However it is noted here at conceptual level as it challenges the notion of disruptive innovation principle No. 2, which states that "markets that don't exist can't be

analysed" (Christensen, 2013, p. xxii). In the case of technology and languages, the markets do exist, however they are small and potentially less well understood than other markets (subjects with larger enrolments). In the case of languages, this is exemplified in the introductory discussion in Chapter 1.4 Perceptions of Learning. Liddicoat et al. (2018) and Kavadias et al. (2022) suggest that despite system level attempts at innovation and change, traction in languages learning can suffer from relatively simple forces such as a perceived lack of relevance and lower rank when compared to other subjects, despite an apparent marketability of some languages (e.g. languages of foreign trading partners). This discussion proposes that amid these perceptions, the disruptive educator needs to analyse deeper into the perceptions of value held by the small markets that do exist to better understand how present value can be communicated more widely. Instead of moving upwards by developing improved policy, or administration led initiatives, this discussion proposes that the disruptive educator first goes 'down market', deeply examining the value held by the small market which does exist.

5.3 Value Proposition and Motivation – Research Question 2

High-level findings statements were identified that broadly addressed Research Question 2 (RQ2)

Research Question 2 (RQ2)

- To what extent did value propositions presented by those subjects, and resulting from the conceptualisation strategy, motivate students to study those subjects?

High-level statements addressing RQ2, found in Boxes 11 to 15, Chapter 4.3.5.

1. Participants were able to identify relationships between concepts within their subjects and offer proposition statements about their subjects that conveyed specific meaning.
2. Participants strongly communicated both **present** *and* **future** value at an **individual** *and* **societal** level from studying their subjects.
3. Participants engage in reasoning about the value perceived in their subjects and how this impacts their learning and growth.
4. Participants expressed value from **positive** *and* **negative** perspectives in terms of **expected** versus **actual** experiences.
5. Participants expressed a more than neutral extent of value perception as a motivating factor in studying their subjects.

The following sub-sections discuss these statements with respect to the literature and conceptual frame.

5.3.1 Propositions are rich and diverse

Table 62 Proposition Themes

Proposition Themes Schools A, B, C
Value perception
Reasoning
Learning
Economic development
Vocation / tech. discipline
Insight
Motivation / Aspiration
Efficiency / Improvement
Function / Utility
Making / Creating
Frustration
Choice
Passion
Culture
Language
International relations
Understanding
Connection
Communication

To commence this section, the use of the word 'proposition' as defined in Chapter 4.3 is highlighted again here for reference. For this study, the word 'proposition' is defined as "the act of proposing or a proposal of, something to be considered, accepted, adopted, or done" and "a thing, matter, or person considered as something to be dealt with or encountered" (Macquarie, 2024). Student participants made statements conveying specific meaning about their subjects that are considered, accepted, adopted, done, encountered, or illustrated. These are considered in the context of value, and how that value influenced decision making with respect to subject selection.

Prior to discussing the influence of value in subject selection, this study shows that propositions proceeding from conceptualisations of subjects by participants are rich and diverse. This is considered important as it illustrates what students bring to classes independent of learning. Table 62, shown right, lists proposition themes ranging from value, to vocational, motivational, functional (utilitarian), cultural, cognitive, and communicative. Participants demonstrated that they were fully engaged with the task and possessed the capability to draw together relationships between conceptualisations to create propositions for consideration. This flow of logic is outlined in the conceptual frame in Chapter 2.11. The implication for educators in this context is that student potential for engagement and performance in the subject is higher than what might initially be expected. The complexity illustrated in concept maps by some participants as shown in Chapters 4.3.1 – 4.3.3 is an example of this potential. Participant engagement in the data collection task was consistent, and complete, in both Phase 1 and 2 as discussed in the findings.

The richness and diversity of propositions offered by participants presents an opportunity to the disruptive educator to leverage the conceptualisation of 'learning as practical involvement' discussed in Chapter 5.2.2. Whilst this opportunity hints at the notion of 'change' or 'improvement', it is stressed that 'reform' is not being suggested at this point. Considering reform either at school or curriculum level begins the sustaining approach to innovation of adding to or improving the current product offering, in this case technology and languages subjects. As previously discussed, education reform can also be an imprecise concept with multiple interpretations of the relationships between curriculum, policy, and pedagogy (Gilbert, 2010). This discussion proposes that educators can explore a path possibly considered counterintuitive by examining the perceptions held by students and leveraging them against the curriculum currently present. It is not suggested that perceptions should drive or dictate

curriculum, as the teacher ‘in the moment’ has neither the flexibility, nor the authority to make ad hoc curriculum alteration decisions. As previously stated, disruptive thinking is ‘alternate thinking’. At this point, the perceptions held by students can be used uniquely in each school context as a lens through which to view the curriculum to help maximise the value expected and subsequently experienced by students. The notion of using student perception as a lens through which to interpret curriculum is explored further in the following subsections.

5.3.2 A model for teachers: present, future, individual, societal

The discussion thus far shows that the concept mapping method (Novak, 1995) employed in this study produced rich data. Participants conceptualise their subjects as a place of learning in which they are actively and ‘practically’ involved. Whilst reform is active in education, and presently so in the case of School A iSTEM students, innovation was not broadly conceptualised, referred to, or even desired as recorded in participants’ concept maps and follow-up interviews. Participants can and do engage in reasoning about the nature of their subjects and experiences within them. Value is perceived by participants across a range of themes, perhaps most notably in the theme of ‘learning’. The conceptual frame used in this study is based on the process of concept mapping. Participants were capable of expressing their conceptualisations of their subjects, and then drawing together relationships between elements connecting their conceptualisations to form propositions that conveyed specific meaning. As noted in the findings statements listed above (Chapter 5.3), participants strongly communicated propositions of both present and future value at an individual and societal level from studying their subjects.

Research Question 2 (RQ2) examines the extent that value propositions presented by those subjects are perceived to motivate students to study those subjects. At this juncture, this discussion proposes that the line of enquiry and methods employed in this study offer the opportunity to develop a model for teachers that can be used in localised contexts. The model can be used to better understand student conceptualisation, perception of value and improve practice. An extension of this model can be used by schools and administrators to address the dilemma stated in this thesis and provide better guidance to students in their selection of learning pathways and is discussed further in Chapter 5.4. Prior to outlining the model, clarification is provided on two issues: generalisability and the study of ‘motivation’.

Generalisability

The study took place in three schools which are regionally diverse from one another. Two are in New South Wales and one in the Australian Capital Territory. The schools are similar in demographic, are K-12 schools, and are coeducational independent Christian schools. Whilst the schools are similar in some respects, each school is acknowledged to be unique, and the

responses collected at those schools are considered to be context-dependent (see Chapter 3.6.3). As previously stated, teachers using the methods of this study would receive data in their own context in the same way as data were presented to the researcher. That is, the data would be useful for that context. Since each school is unique, teachers could share the benefits of the methods employed with teachers in other contexts. However, the actual conceptualisations and value perceptions may not apply across other school contexts. As an example, the factors of present and future value at both individual and societal level apply for schools A, B, and C in this study. However, they may be replaced by other factors if the study was conducted at three other schools.

Motivation

The primary research question in this study examines student conceptualisation of the subjects that students undertake. By examining value proposition and motivation as an underlying research question, this study acknowledges that 'motivation' is a field of educational and psychological research that has attracted significant attention. Graham et al. (2002) notes that "the scientific study of motivation as a discipline separate from learning began in the 1930s" where theories were based largely "on the ideas of homeostasis and hedonism as fundamental principles" (p. 1691). Other distinctions include the differences between motivation, achievement, and learning. In this study, neither achievement, nor learning were considered as factors that could influence motivation to select the subject. However, conceptualisation is an inherently cognitive process as participants engage in "the act or process of knowing" (Macquarie, 2024) and expressing their perception of their subjects through their lived experience. Therefore, it is recognised that this study could be considered to sit within other frames of investigation where cognition is a factor in the examination of motivation.

Graham et al. (2002) note that expectancy value theory (as exemplified in the study by Heyder et al. (2017) in Chapter 1.4) is one such approach. However, the focus with expectancy value theory leans heavily towards 'achievement', with a focus on the motive for, probability of, and incentive for success (Graham et al., 2002, p. 1691). Participants express an awareness of the potential for future success in the findings of this study, yet they were not specifically prompted to consider it. In that context, 'success' as a motivating factor for subject selection is considered a finding of the grounded nature of this research.

A theoretical frame closer to the intent of this study is found in 'achievement values', which is an approach to motivation research emerging amongst other contemporary theories since the 1980s and widely attributed to the work of Jacquelynne Eccles and Allan Wigfield (Graham et al., 2002). Achievement values resonate with this study as tasks undertaken by students in an 'achievement values' framework are examined

> in terms of their attainment value (the perceived importance of doing well), the intrinsic value (how much enjoyment the individual derives from engaging in the task), utility value (how the task relates to future goals), and costs (the undesirable consequences of engaging in the task).
> (Graham et al., 2002)

The distinction of 'achievement values' is provided here as propositions indicating intrinsic value, utility value, and costs are evident in findings. In particular, there are instances in the findings reported in Chapter 4.3.2 where School B participants expressed disappointment in expected intrinsic value and an unexpected cost in studying technology subjects where their experiences did not match their expectations. Such expressions included,

- I wish this subject could be like I thought instead of lots of theory and listening.
- I thought this subject we would have more hands-on tasks.
- Two very different ends of the spectrum, what I thought prior to the course.

However, there is a subtle and important difference in the way that 'values' are defined in the 'achievement values' frame to the way that 'value' is used in this study. According to Wigfield and Cambria (2010) "Eccles and her colleagues define values with respect to the qualities of different tasks and how those qualities influence the individual's desire to do the task; hence the term task value" (p. 4). The doctoral study considered for this thesis approaches value through a conceptualisation frame and addresses the dilemma through the disruptive innovation lens. Since disruption is a frame for innovation first examined in the corporate context and then applied to education, this study leans on the commercial notion of value.

With respect to a commercial notion of value, students could be considered as consumers of the subjects they select, and that the subjects selected 'do' a certain job. In the context of discussing why students are often unmotivated, Christensen et al. (2010) contend that customers tend not to think of themselves being in a category that suits a particular product. "Rather, customers just find themselves needing to get things done" (Christensen et al., 2010, p. 163). A further parallel in this thesis is therefore drawn similar to the Research Parallels in the conceptual frame (Chapter 2.11) which are drawn from the underlying principles of disruptive innovation. Like the way that customers need to get things done, students facing elective subject selection must address their learning pathway as something that needs to be done. This discussion proposes that students tend not think of themselves in a category that suits a subject or stage of schooling. However, that they do recognise that a subject selection, or undertaking an elective subject, is something that 'needs to be done'.

In a commercial context, Christensen et al. (2010, p. 163) purport that marketers who sell to customers "predictably need to see the world through the eyes of those customers". Looking through the lens of 'jobs to be done', marketers need to understand the jobs that their

customers are trying to get done. For maximum effect, Christensen et al. (2010) propose that "the job, and not the customer or the product, should be the fundamental element of a marketer's understanding" Christensen et al. (2010, p. 163). For the disruptive educator, this mindset offers an alternative perspective for the 'delivery' of their subject. Several constraints exist for teachers in any subject. Curriculum and policy are regulated by jurisdiction. Textbooks are often prescribed. Daily school life is managed by administrators, although there may be some flexibility in school day structure and timetabling from year to year. Infrastructure and financial resources are institutionally controlled. However, a teacher's understanding of the jobs to be done, as perceived by students, is limited only to the teacher's depth of insight into student perception. This discussion proposes that understanding student conceptualisation through visual methods such as concept mapping can form the basis for localised models of improved practice: first for the teacher/student through improved subject experience and learning pathways, second for school administrations as a way to address the dilemma.

A Model: concept mapping for new value

A key high-level statement proceeding from findings included that participant responses strongly communicated both **present** and **future** value at an **individual** and **societal** level from studying their subjects (see Chapter 4.3.5). Examples include,

- Better living (School A, technology – present value, individual/societal)
- Helps with adapting, making you a better person. (School B, languages – present value, individual/societal)
- Requirement for a scholarship, career. (School C, languages – future value, individual)

These value factors are given further depth when viewed next to the proposition themes shown in Table 62. Whilst curriculum, and to some extent teaching texts, are fixed, these themes offer insight into the participants at Schools A, B, and C and the way in which they perceive the jobs that their subjects are 'doing' for them. Educators viewing the student experience through the 'jobs to be done' mindset can begin to build an alternative perspective on how to provide maximum value to their students.

The conceptualisation process, as outlined in the conceptual frame for this study, is a key part of this process. Conceptualisation establishes what students bring with them in terms of their initial understanding, knowing, and expectation of their subjects. As this study has shown, participants could establish conceptualisation, and then draw relationships together to form propositions; things to be considered. This took place outside of the boundaries of curriculum and at the same time did not reject or attempt to modify curriculum.

This model proposes that at the point where educators sense the need to improve or reform curriculum, (a sustaining approach to innovation), there is opportunity to first go 'down market'. This entails accepting the curriculum and general context (e.g. low participation; struggle for

resources) and focussing heavily on the 'jobs to be done' as expressed by current students (a disruptive approach to innovation). Christensen et al. (2010) provide a helpful parallel from the commercial context which also issues an ominous warning to the innovator at this point.

> An innovation that makes it easier and cheaper for people to do what they're trying to do is what is called a *killer app*(lication). An innovation that makes it easier and cheaper for people to do what they're *not* trying to do, in contrast, faces an uphill death march through knee-deep mud before it fails.
> (Christensen et al., 2010, p. 167)

The model therefore focusses on gaining understanding of what students are trying to do. It is based on a simple method which can be implemented in real time at the commencement of a subject, or throughout. The model is presented diagrammatically first and is followed by aggregate and specific examples derived from findings in this study.

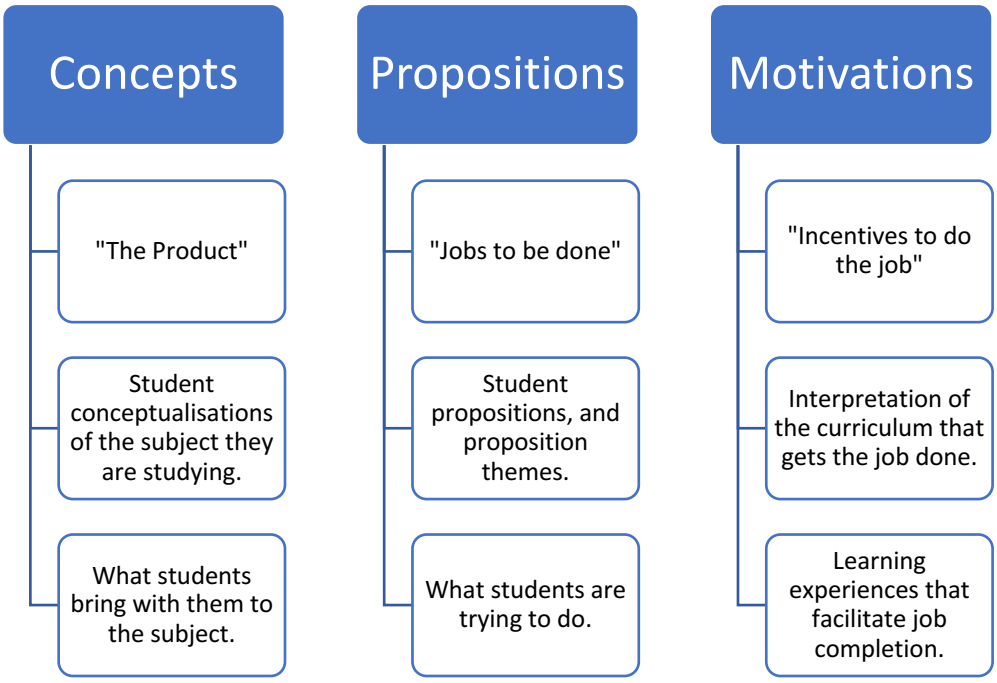


Figure 51 A model for teachers

Figure 51 illustrates a simple approach that can be facilitated by concept mapping. Participants in this study produced concept maps when they were well into their studies of their subjects. Due to constraints of scheduling and access, it was not possible to complete data collection at the commencement of study, and then again at a point in time throughout the course of study. It is suggested, however, that engaging in the process at the commencement of study would yield similarly useful results. It is also acknowledged that the association of a 'subject' with a 'product' may be controversial. By way of clarification, this model is not advocating for a commercialisation of subjects at school. The association of 'product' in this context is made for

the purposes of drawing a parallel to innovation as examined in a commercial context. That said, subject electives offered to students could be seen as a standalone offering competing with other subjects for enrolment. Subjects have specified curriculum content, are vetted and approved by regulators, and are delivered in accordance with regulation controlled by local jurisdictions. Elective subjects can be chosen or rejected in a manner similar to other retail products. For the purposes of this model, the notion of ‘product’ is considered appropriate.

An aggregate example of the model from this study

Considered in aggregate, participants from Schools A, B, and C strongly communicated value in terms of the present and future, and individual and social perspectives. Using the model in Figure 51 as a guide, it is possible to interpret where these value factors originated.

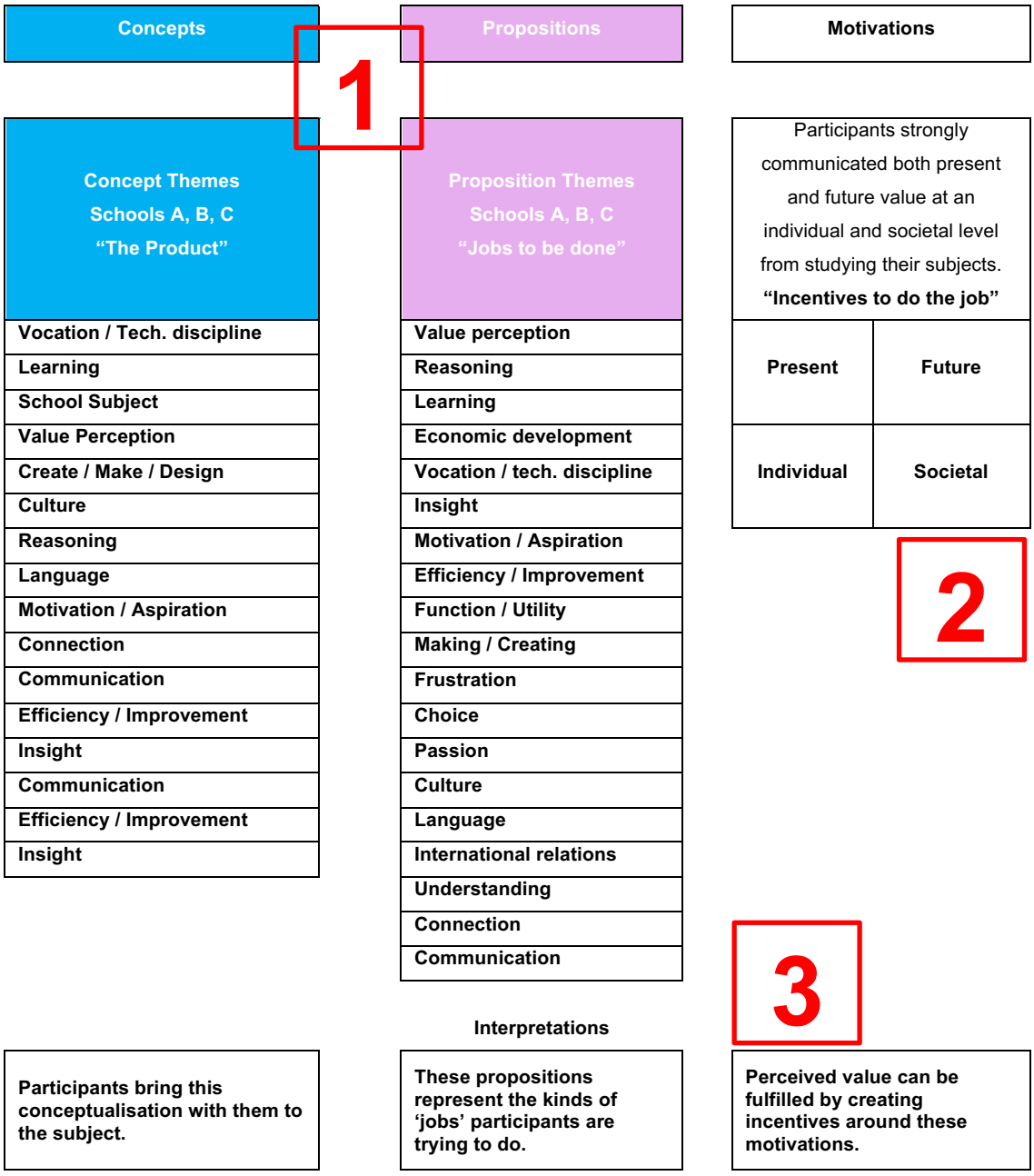


Figure 52 Aggregate example of the model in use

Figure 52 is superimposed with numbered boxes indicating the process by which data collected from the model may be interpreted. They are described below.

Box 1: Student conceptualisations of their subjects (the product) are created from which propositions (what the product does for them) are derived.

Box 2: Motivations communicated by students are identified, indicating incentives perceived by students to study that subject.

Box 3: Interpretations of conceptualisation, proposition, and motivation enable deeper understanding of student conceptualisation and motivation, providing a platform from which to develop strategy.

To move forward from the data presented in Figure 52, the educator can develop targeted action statements as a strategy for how their subject may be implemented *for the cohort that produced these data*. It is stressed that these data are produced by Schools A, B, and C and are not considered typical of any school. When considered in aggregate as shown here, action statements developed by teachers could include,

- Technology students have a strong desire to learn with practical tasks that are meaningful in the present and will continue to develop their future interests and pursuits in technology.
- Technology students bring with them a desire to design, make, and create as they consider building their skills for their vocation.
- Technology students are motivated by a desire to design and make for future global economic development.
- Languages students aspire to learn language to contribute to improved future international relations.
- Languages students are motivated to develop communication skills that help them build understanding between cultures.
- Languages students apply reason to connect acquired languages capabilities as a skill that they possess and can continue to refine.

It is acknowledged that the above statements are speculations based on the findings in this study. In aggregate, they may also be considered too nebulous to be effective. However, this discussion proposes that the process outlined in the model above does indicate a deeply profound outcome. That is, in guiding participants (students) through their course of study, educators are not merely facilitators of education, but also custodians of participants' sense of value and aspiration. To illustrate, two further examples are discussed. One as an individual, and one as a cohort.

An individual example: School B Languages

Table 63 (right) is an excerpt of Table 53 (Chapter 4.3.4) and shows an area of concentration in themes indicated by Rectangle 3. The discussion thus far has focussed on the first three themes of value perception, reasoning, and learning. This example is pertinent as it highlights the depth of findings in this study. The model described here is used in this specific example for languages, where a concentration of themes was identified for School B languages as indicated by Rectangle 3.

Table 63 Proposition Themes - School B Languages

Proposition Themes	School B	
	Languages	
	Phase 1	Phase 2
Value perception		
Reasoning		Phase 2
Learning		
Economic development		
Vocation / tech. discipline		
Insight		Phase 2
Motivation / Aspiration		
Efficiency / Improvement		
Function / Utility		
Making / Creating		Phase 2
Frustration		
Choice		
Passion		
Culture		
Language		
International relations		
Understanding		
Connection		
Communication		

3

Figure 53 below is a copy of Figure 38 appearing in Chapter 4.3.2 and illustrates a section of a School B languages participant's response. It is provided again here as it is a useful example of the model at work at the scale of an individual participant. The overriding concept identified in this concept map is French as a subject (*the product*), indicated by the cyan 'C'. The proposition indicated by the purple 'P' highlights the 'key reason' why the participant chose the subject (*the job to be done*). In Chapter 4.3.2, the findings identified the language of utility used by this participant.

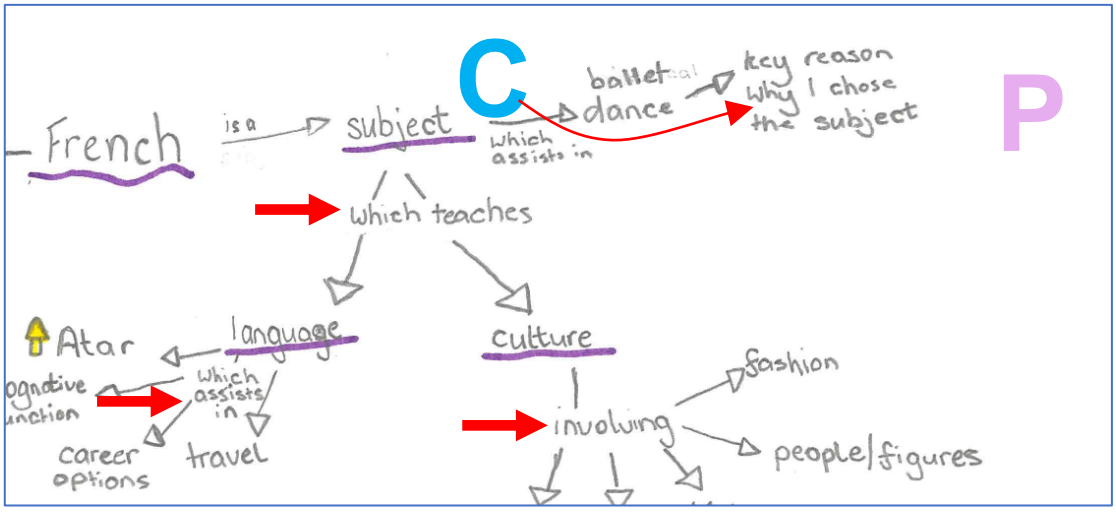


Figure 53

The subject, French, is facilitating a job to be done. As noted in Chapter 4.3.2, the following are highlighted by the red arrows on Figure 53,

- The subject does something: it *teaches*.

- What the subject 'does'. Provides benefit to the participant: it *assists* in facilitating a key motivation for the participant.
- The subject is made of complementary components working together: *involving*.

For this participant, the subject of French meets an expectation in the present that it will contribute to a future interest in ballet and dance. Strong links are evident to the proposition themes collected for the cohort (shown in Table 63 above) of language, culture, and choice. In examining the connections this participant has made, 'passion' is also a consideration. This finding, through the application of the model, provides insight to the educator that exploring French through the lens of ballet and dance is likely to have positive impact on the student. Notably, ballet and dance are components of other subject areas in the creative arts. This linkage also provides early indication of potential complementary value between languages and subjects within the creative arts. Complementary value between subjects and faculties is discussed further in Chapter 5.4.

A cohort example: School A Technology

School A Technology participants studied iSTEM and provided fewer overall proposition themes. These included,

- Value perception
- Reasoning
- Learning
- Economic development
- Vocation / technology discipline

This example is pertinent as it highlights how participants engage in reasoning to identify current and future value in their experience of the subject and its wider impact. It is also an example of the benefit provided by follow-up interviews as a supporting strategy to concept mapping. The following statements are taken from audio transcripts during Phase 2 data collection with School A participants (Appendix I). The discussion amongst participants begins to take a turn at 07:08 (timecode on the transcript) with a comment by Participant 4.

Participant 4: 07:08 *Well I believe most technology has been getting off track. ...and how the user is the most important part of the company because without the users, the company can't continue to go because they're not getting their stable income.*

To clarify the change in direction, the researcher asks a further question to all five participants at 08:13.

Researcher: 08:13 *So let me see if I can get a better understanding of where you're going*

with that. And I'll put this question to all five of you. We'll play fill in the blanks. To produce a better product, the company must 'blank' the user. What one single word would you put in there?

Participants provide notable responses, including,

Participant 2: 08:31 *Respect*
Participant 3: 08:33 *Understand*
Participant 4: 08:35 *Honour*
Participant 5: 08:39 *Yep, they're all good.*
Participant 6: 08:43 *Interest*

Note: The 5 participants are labelled 2 – 6 in the transcript as 'participants in the conversation' including the researcher.

It is reiterated at this point that participants were in Phase 2 data collection and had been presented with propositions from School B Language participants. The extent to which the above responses of 'respect', 'understand', 'honour', and 'interest' are influenced by those propositions is unclear. However, proposition statements made shortly after the above responses indicate that this cohort is clearly making connections between their subject and wider societal impacts. Statements include,

Participant 4: 09:39 *...making the projects a little bit more involved with connecting with other people and things.*
Participant 2: 11:27 *I think feeling like you're doing something to help people would make students take more consideration in what they do in their projects. So that they're not just making a project, they're designing something for someone.*
13:23 *...how could you build something that will benefit others?*
Participant 4: 15:08 *Pretty much if you put something in front of a student that says, oh look, there's something and it's going to help this poor person living in another country, they're going to be like, oh no, they'll have a reason to do it and they'll have more motivation to do it.*

These responses were less expected. They indicate to the educator that this cohort has an awareness of the wider impact of the subject and that allowing the implementation of the subject to be influenced by this knowledge is likely to be positively received by students. This discussion proposes that such responses could provide enough evidence to the educator that further investigation with students could identify how projects (subject content) could align with responses of this nature. Since these discussion findings are for the School A cohort, the model is illustrated in Figure 54 below.

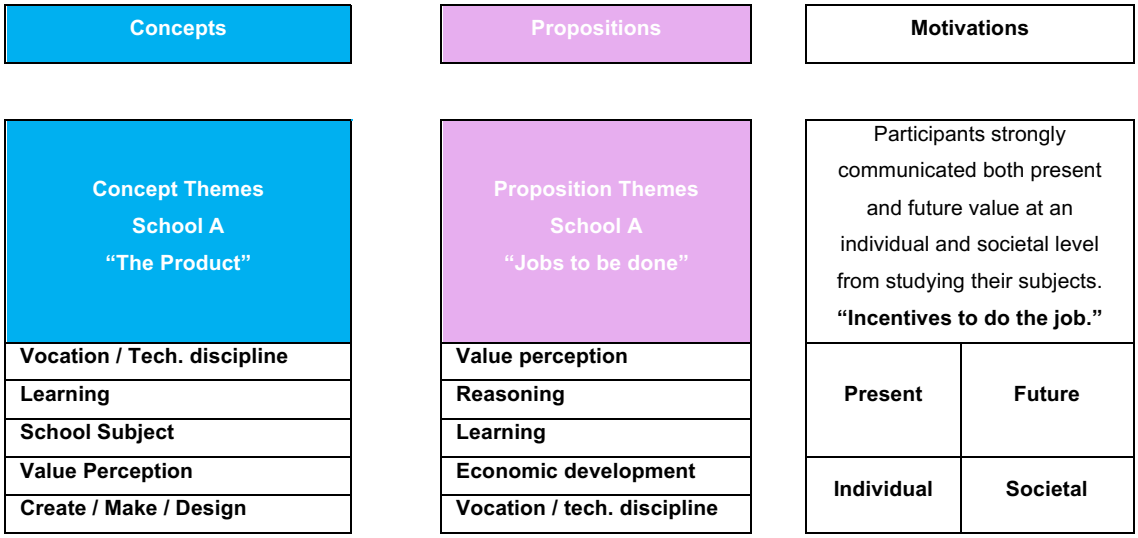


Figure 54 The model applied to School A Technology participants

Action statements that could proceed from the above investigation of transcript responses and consideration of the model shown in Figure 54 above include,

- Students perceive value in the development of projects that benefit others and contribute to wider economic development.
- Technology projects in iSTEM can be enhanced when considered from the perspective of the individual and society.
- iSTEM students engage in reasoning to consider the wider benefits of their learning and of the projects they make.

The success of the above action statements is predicated on the educator's willingness to improve outcomes using the model. It is also acknowledged that the examples discussed above are positive in nature, and that data collected in any given context may not easily lead to positive or useful responses. Development of appropriate action statements resonates with the comment (and warning) by Christensen et al. (2010, p. 167) noted above. If action statements are developed that attempt to facilitate innovations (jobs to be done) that are not the 'jobs' required by students, then the innovations have a higher chance of failure. Findings in this study provided evidence where participants reported that the subjects they were studying did not meet expectations leading to expressions of negative sentiment (see Chapter 4.3.2). Examples of such findings are discussed through the conceptual frame in the following section.

5.3.3 Expectation and limitation: a restrictive juxtaposition

The first underlying principle of disruptive innovation states that "companies depend upon customers and investors for resources" (Christensen, 2013, p. xix). Proceeding therefrom, Research Parallel 1 states that schools and subjects offered within them depend on students for

funding and survival. Whilst this may seem overly simplistic, and obvious, the distinction that must be made for the context of the study is that technology and languages subjects examined in this thesis are elective subjects. Technology and languages subjects do exist as mandatory variants in lower years, however the Year 9 and 10 offerings are elective and are subject to enrolment numbers by choice. For these subjects to survive, there must be students to enrol in them. A risk exists for the subjects (as with any subject) that the conceptualisation of the subjects by participants does not match the actual experience of the subject. As stated in Chapter 4.3.2, participants expected 'X' and experienced 'Y'. Participants are 'limited' in the fulfilment of their expectations. The dynamic of expectation and limitation is described as a 'restrictive juxtaposition' as the ability to switch subjects may be hindered by administrative hurdles or the lack of viable subject alternatives. The student remains stuck. Evidence in the findings illustrates this dynamic and provides an opportunity to consider the model described in the preceding section.

Table 64 is an excerpt of Table 53 Proposition Themes which appears in Chapter 4.3.4. It is superimposed with red Rectangle 2 to indicate an area of concentration in proposition themes identified for School B technology participants. The table also indicates the previously discussed themes of first interest including 'value perception', 'reasoning', and 'learning'. Similar to the example of School B languages (Table 63) in the preceding section, Table 64 is useful as it exemplifies depth in the data. The theme of 'frustration' stands out amongst the themes highlighted by rectangle 2 as it represents the expectations / limitations dynamic. The principle of data carrying meaning even when appearing only once (Drisko & Maschi, 2015) is drawn upon in this instance as the presence of 'frustration' represents risk to the subject.

Table 64 Proposition Themes - School B Technology

Themes	School B	
	Technology	
	Phase 1	Phase 2
Value perception		
Reasoning		
Learning		
Economic development		
Vocation / tech. discipline		Phase 2
Insight		
Motivation / Aspiration		
Efficiency / Improvement		
Function / Utility		
Making / Creating		
Frustration		
Choice		

2

Proposition statements produced by School B Technology participants that were themed as 'frustration' include,

- I wish this subject could be like I thought instead of lots of theory and listening.
- I thought this subject we would have more hands-on tasks.
- I thought this subject would be mainly design and the design process, but it was mostly research assignments.
- Two very different ends of the spectrum, what I thought prior to the course.
- Not much creativity in class.

It is acknowledged that broad conclusions cannot be drawn from these examples in the data, in this case for two reasons. Firstly, the data were collected during the COVID-19 pandemic which resulted in disruption to normal classes and some restriction in access to usual teaching facilities. This may have been an influencing factor on classroom experiences. Secondly, the above responses could simply be a realisation by participants of a poor subject choice. However, the pandemic and poor choice notwithstanding, this discussion proposes that use of the model described in the preceding section could be applied in this case in two instances.

1. as a preselection tool for students in the year prior to elective subject selection.
2. in real time during the course of delivering the subject to gauge perception and adjust, modify, or differentiate subject experiences as necessary or practicable.

Although possible, the discussion acknowledges that the first instance may be too time and resource consuming, and therefore impractical to implement. However, the second instance is considered more feasible as the concept mapping task could be easier to incorporate and implement as an in-class exercise. In either case, it is suggested that persistence by educators in a trajectory unaware of frustration themes is less likely to deliver their subjects in a manner that matches the 'job to be done' perception of the student. Educators in such a position place themselves at risk of falling victim to Research Parallel 1. That is, continued limitation of student experience could limit the subject out of existence through declining enrolments.

5.4 Complementary Value – Research Question 3

High-level findings statements were identified that broadly addressed Research Question 3 (RQ3)

Research Question 3 (RQ3)

- To what extent are there complementary value propositions between languages and technology subjects, and how do students express them?

High-level statements addressing RQ3 found in Boxes 21 to 23, Chapter 4.4.4.

1. Participants were able to identify and express complementarity between subjects when presented with conceptualisation and value perceptions from participants studying other subjects.
2. Technology participants expressed complementarity between technology and languages through awareness of people, society, and the impacts of technological outputs on the world around them.

3. Languages participants expressed complementarity between languages and technology by emphasising languages as a ‘skill’ providing the potential to overcome challenges in logical and creative ways.

The following sub-sections discuss these statements with respect to the literature and conceptual frame.

5.4.1 Shifting perceptions and new value

The closing observation of findings in Chapter 4.4.4 revealed that complementary value between technology and languages subjects was evident in the data. It was also noted in Chapter 5.2.1 of this discussion that ‘innovation’ was not broadly conceptualised amongst participants. A connection is drawn at this point between the wide-ranging calls for innovation in education (Chapters 1.2, 1.2.1, 2.6, 2.10), the lack of conceptualisation of innovation in the data, and the ability for participants to reconceptualise their subjects when presented with propositions by the alternate cohort. There is no evidence in the data that participants were seeking improvement of their subjects in the sense that they needed to be more innovative. However, as discussed in the previous section (Chapter 5.3.3) there was evidence of frustration when participants’ experiences of their subject (School B Technology) was not in line with their expectations of value in the subject. Whilst this dynamic could be considered a quasi-call for improvement by School B Technology participants, this discussion proposes that other factors are at play. There is also no evidence in the data that participants rejected the notion of complementarity, either by propositions recorded on concepts maps, or by refusal to properly complete the concept mapping task in Phase 2. As discussed in Chapter 4.4, participants produced reliable data in accordance with the data collection instrument in both Phases 1 and 2. Considering these observations, this discussion proposes that participants’ ability and willingness to consider alternate value propositions in the context of their own subject represents a form of ‘disruption at work’.

Disruption at Work

The preceding section (Chapter 5.3.3) describes how application of the model for teachers proposed in this discussion can highlight the problematic dynamic between students’ expectations and experiences of a school subject; the restrictive juxtaposition. The findings discussed were for School B Technology participants. A similar dynamic also existed for School A Technology participants. The recurrence of the ‘restrictive juxtaposition’ in School A findings further highlights an example of difficulty in managing situations under pressure from Research Parallel 1, whereby continued limitation of student experience potentially exerts further pressure on declining enrolments. The identification of such pressure could be perceived as negative at face value; however, this discussion proposes that there are examples in the data for School A

which provide a window into disruption at work. The ‘disruption at work’ is expressed by participants in their consideration of alternatives to their lacklustre learning environment. The data show that participants prefer learning over ‘no learning’.

The discussion in Chapter 5.3.3 suggested that educators who persist with a trajectory whilst unaware of themes of frustration amongst their students are less likely to deliver subjects in a manner that matches the ‘jobs to be done’ perception of students. This resonates with statements by Christensen et al. (2010, p. 168) who propose that “consumers demonstrate daily the propensity to prioritise what they want to accomplish, not what they are told they should accomplish”. Responses from School A Technology participants in Phase 1 follow-up interviews exemplify this dynamic. At 21:01 (timecode in the transcript, Appendix I), the researcher asks specifically about potential deficiencies in the iSTEM subject that participants were studying.

Researcher:	21:01	*So coming back to iSTEM, where do you think the subject that you’re doing now is perhaps deficient and what would you like to see more of?*

The content of participant responses was less expected, with a clear focus on learning, both in terms of receiving instruction and being involved in the learning process through practical experiences (see Chapter 5.2.2).

Participant 2:	21:18	*Teacher to class learning*
Researcher:	21:20	*So you’d like to see more direct instruction. Is that how you’d describe it?*
Participant 2:	21:24	*Yeah. And the teacher’s teaching the class about that topic.*
Participant 3:	21:30	*So not as loose as it currently is, so.*
Participant 5:	21:36	*Yeah, because I feel like, at the moment, sometimes it feels to be disorderly and just there’s no structure at all.*

The dynamic that emerged in the follow-up interview began to express a dissatisfaction, indicating that an expectation, or job to be done by the subject was not being fulfilled. In the context of receiving less direct instruction, participants did not perceive their ‘freedom’ as valuable.

Participant 3:	22:30	*I’m just saying, it’s really loose. I’m just saying it’s a bit too loose in our classes, because some people, when they’re tyring to move forward, they go back instead. So, some people are actually making their way to the finished goal. And some people are just not making it. They’re just not. They don’t know what to do. They don’t know which path to take. And if they have someone to guide them, they’ll make it much easier for them to reach the goal.*

The above comments were made as observations of participants' current experience. The process of a teacher persisting with a trajectory while unaware of student frustration becomes evident in participants' comments following, where a new teacher starts teaching them.

Participant 4: 22:54 *I think it's hard to say for my teacher right now, because the teacher we had before was pretty rubbish. He didn't do anything for us. He pretty much left it to us to do nothing. He wasn't there half the time. He was ditching students.*

Participant 4: 23:14 *But our new teacher...he's had to pick up all the remains of what the teacher before left. ...So I think he's doing a good job, but I think more theory lessons, like whole class theory lessons, not individual, would be good.*

Participant 1: 24:40 *You should see the structure of our lessons. It's just come in and just [inaudible: 00:24:50]. It's very easy to bludge*.

The transition from one teacher to another (the previous teacher resigned), resulted in a change of staff, however the trajectory of delivery of the subject continued. Participants clearly communicate their preference for 'learning' rather than disorder, loose classes, and the ability to 'bludge'. The intensity of responses is exemplified in responses including,

Participant 3: 22:30 *And some people are just not making it. They're just not.*

It is acknowledged that the desire for learning in place of what could be called 'disorderly freedom' in this case is the result of highly motivated students. These participants may also be described by teachers generally as a 'good class', and not typical. However, the data are not considered broadly generalisable (Chapter 3.6.3) and are considered meaningful only in this context. That is, the data remain context-dependent as per the data collection instrument (Novak & Cañas, 2008). This discussion proposes that forces of disruption are at play here since participants do not prefer 'no learning'. Rather, the participants begin to consider alternatives.

School A did not have languages participants in the study; however, technology participants were aware of the structure of the study and that languages students from other schools would participate in the study. Shortly after the expression of dissatisfaction in the discussion above, the researcher used the semi-structured nature of the follow-up interview to examine for the receptiveness to disruptive options in elective subject selection. This direction was taken towards the end of the follow-up interview to minimise perception of 'leading questions'. In place of 'no learning', reflected in the lack of instruction received in iSTEM, the researcher offered the alternative of a disparate choice, languages.

Researcher: 25:13 *Who would choose to do a language here, if you had a good set of choices?*

By show of hands, four of five participants indicated that they would choose a language. This is noteworthy since their frame of reference was limited in that year 9 and 10 languages classes are rarely offered at School A due to low numbers. The landscape for learning languages at School A is challenged and yet participants openly considered languages as a disparate option to the iSTEM elective they had selected. This could indicate that they preferred learning 'anything' over 'nothing'. As participant 3 commented above, some students were simply not reaching their goals. They were not 'making it'. The 'job' they were trying to do (reaching their goals, making it), was not being facilitated by the subject. Moreover, choice and the availability of quality resources was a key consideration for any possible alternative.

Participant 2: 26:19 *Yeah. And also because many other schools get language choices and we Don't. We get one choice throughout every single time, because unqualified teachers, and so more options would have been great. And I would have definitely chosen that over one of my electives. And integrated would also be very good.*

The participant is engaging in reasoning about the situation in a manner that resonates with disruption. However, the situation being described reflects the dilemma for the school in terms of Research Parallel 3; markets that don't exist can't be analysed (Christensen, 2013, p. xxii). Schools which require quantification of viable class sizes before committing staff and resources would be ill-equipped to cater for the participants in this situation. The alternate (and disparate) option is likely to be unknown and therefore unquantifiable. However, this discussion proposes that with an effective model for identifying student conceptualisation and value perception, schools could begin to make more informed choices about which subjects to offer and how to resource them.

Raising Disruptive Awareness

A link is drawn at this point between student conceptualisation and value perception as examined in this study and gaining insight into the 'jobs' that students are trying to get done (goals, achievements) with their subject selections. This discussion proposes that such a link enables the process of 'raising disruptive awareness'. As observed in the discussion above, participants preferred alternatives to 'no learning' and could identify them. This research considers the communication of alternatives as an important component for raising disruptive awareness.

Towards the conclusion of the School A Technology participants' follow-up interview, participant 5 gave voice to the concept of integrating iSTEM with languages, naming it iSTEM-L. Prior to this point in the follow-up interview there had been no discussion of integration, or integrating iSTEM with other subjects, or detailed discussion surrounding the integration of the component subjects of STEM (see Chapter 1.1.1). Other than introducing the notion of languages as an alternative subject, there had been no questions by the researcher to lead participants towards the discussion of integration.

Researcher:	26:39	*So integrated, yes? And sorry, because I want to come back to your comment about iSTEM-L. So talk me through that. Do we have a couple of minutes? Can you talk me through that?*
Participant 5:	26:51	*Yes. iSTEM-L. It's where it's iSTEM, so it's science, technology, engineering, maths, but then adds language.*
Researcher:	27:01	*So would you expect to come to the class and learn it in another language or just kind of both.*
Participant 5:	27:07	*Have [inaudible 00:27:08] sessions. And then if you progressed far Enough In the language he could teach how a motor is working in Chinese or something. I don't know [crosstalk 00:27:19]*
Participant 1:	27:29	*That's helpful, because a lot of parts we get are straight from China and we don't understand any of the words.*

At this point the researcher rephrased the proposition being presented by participants for clarification.

Researcher:	28:14	*So let me get this straight. You would want to have some integration of the Language. Not a hardcore, you walk through the door and everything's in another language, but you would be happy to have another language integrated as part of what you had to learn. Would you be happy to be assessed on it as well?*
Participant 4:	28:12	*Yeah, definitely.*
Participant 3:	28:13	*Yeah, definitely.*

The process of working through the participants' conceptualisation of an 'iSTEM-L' subject offers participants the freedom to envisage an alternative to their current situation in which they perceive value. Participants do not foresee a bilingual environment or what might be described as a 'full service' languages class. However, they perceive value in a deeper understanding of the language describing the technology components/parts they receive from China. Disruptive awareness as emerging in this follow-up interview could be of assistance to the educator seeking to align the delivery of their subject more closely with student conceptualisation.

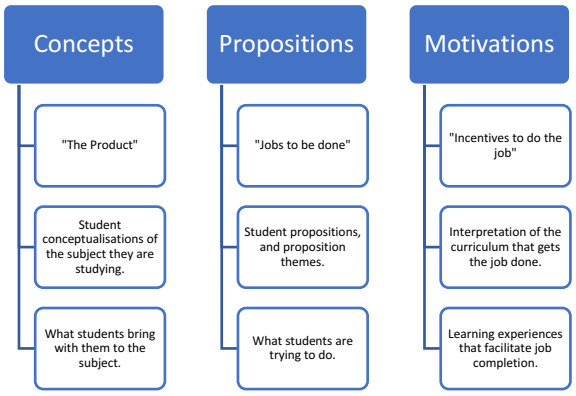
The notion of an iSTEM-L subject as an innovative proposition resonates with the concept of Content Language Integrated Learning whereby subject content is taught in a target foreign language (see Chapter 2.8). However, the data in this study supporting languages integration with technology are limited to this follow-up interview. The concept was not raised by participants at Schools B and C. It is suggested that such an integration offers opportunity to extend this research.

Disruptive awareness as described in this discussion is also seen in the literature on both small and large scales. The study by Kafai et al. (2014) revealed insight into how student identities can change or be reimagined when students are given the right opportunities to extend their skills into other subject areas. On a large scale, the examination of Massive Open Online Courses (MOOCs) in Chapter 2.10 raises awareness with respect to students seeking alternatives to university education. When confronted with limited or no access to a traditional university course, an online offering goes part way to getting the job done of learning. A better alternative to ‘no learning’.

5.4.2 A model for schools

This research shows that student conceptualisations of their subjects resulted in rich data, producing propositions of value across a range of themes. Within these propositions, motivations to select subjects became evident. The model presented in Chapter 5.3.2 offers a process for teachers to gain insight into the conceptualisations that students bring with them to their subjects. It sheds light on the expectations they have of their subjects, and how to facilitate such an expectation. Where practical, the model can be implemented in real time as an in-class exercise either at the commencement of the subject or throughout. On a larger school-based scale, a model is proposed that is based on the model for teachers with recognition of a key impact: and organisation’s capabilities define its disabilities (Christensen, 2013).

In Chapter 1.5 Research Questions it was proposed that the disruptive innovation frame must be used to better equip schools to address the critical factor of resource allocation by considering opportunities for new value. In this context, Research Parallel 4 (RP4) proposes that a school’s ability to allocate resources to high-demand subject will limit its ability to allocate resources to low-demand subjects. The presence of RP4 was exemplified in the preceding section where technology participants simply noted that choice in languages was not available due to demand and access to qualified teachers. If neither teachers nor students are present, then the subject cannot be offered. However, insight proceeding from the model for teachers can inform a model for schools.



The model for teachers shown left in Figure 55 operates on three levels.

- It addresses students at an individual level.
- It operates within the context of a class or cohort.
- It informs subject implementation and delivery.

Figure 55 A model for teachers

At school level, it is acknowledged that the challenges become larger and more complex. However, this discussion proposes that enabling a process that raises disruptive awareness can identify opportunities for new value in subject offerings and learning pathways for students. The model can also be interpreted to operate on three (wider) levels.

- It addresses students across the student body.
- It operates within and across faculties.
- It can influence how and where resources are allocated.

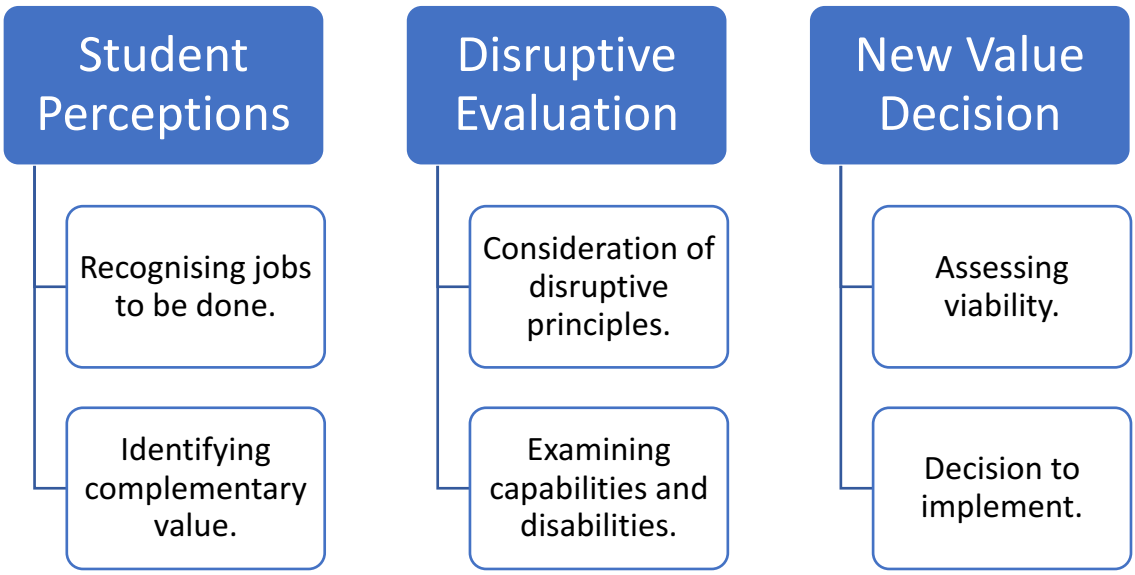


Figure 56 A model for schools

The model for schools in Figure 56 could be used as a broad-based approach for reconsidering current and future subject offerings. It is acknowledged that schools may simply have too many restrictions or limitations placed upon them to consider wider scale change. However, this discussion proposes that the opportunity exists to examine student conceptualisation in a manner not previously conducted. That is, to create a plan for future subject offerings based on questions not previously asked of students via the process of conceptualisation. The model for schools provides a contextually relevant framework for asking such questions. Implementing an

approach of this kind may enhance students' subject selections by better matching subjects with student perceptions of the 'jobs' they are trying to get done. To illustrate how the model in Figure 50 could be applied at contextual level in conjunction with the model for teachers, each component is considered individually below.

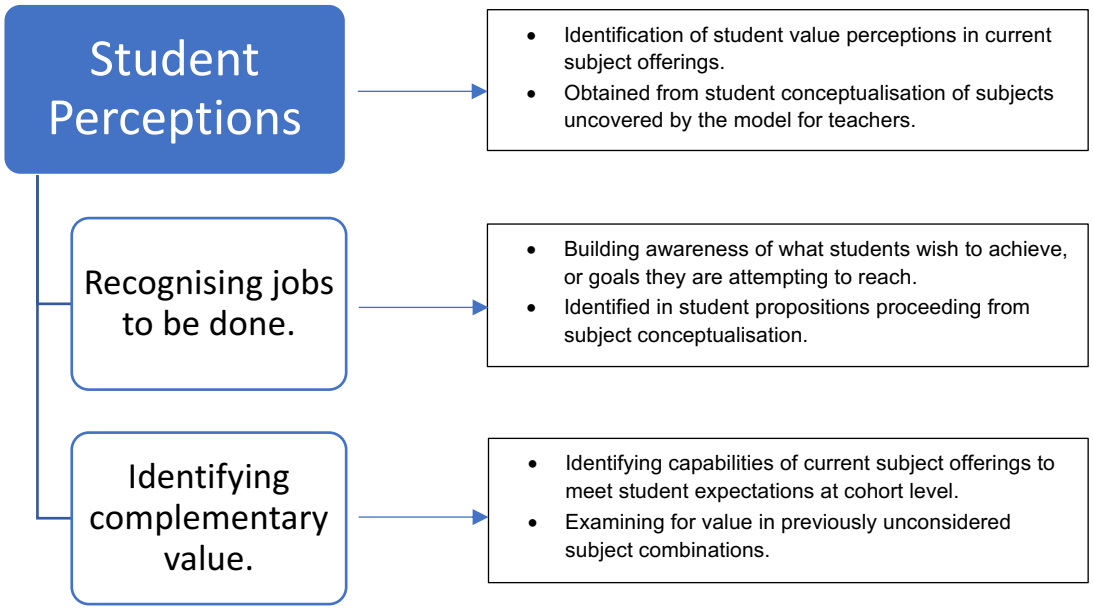


Figure 57 A model for schools. Component: student perceptions

Figure 57 illustrates the initial consideration of the model for schools by gaining high-level insight from application of the model for teachers. Teachers engage with students through concept mapping and interviews at individual/classroom level. Insight gained can be considered by cohort to gain a wider picture of how subjects in their current delivery address student perceptions of the jobs they are trying to get done. Proceeding from such insight, school administrators can gain understanding of how current subject offerings cater to student perceptions based on contextual data. It is suggested that such an approach could provide early identification of shifting trends of value perception within the school cohort.

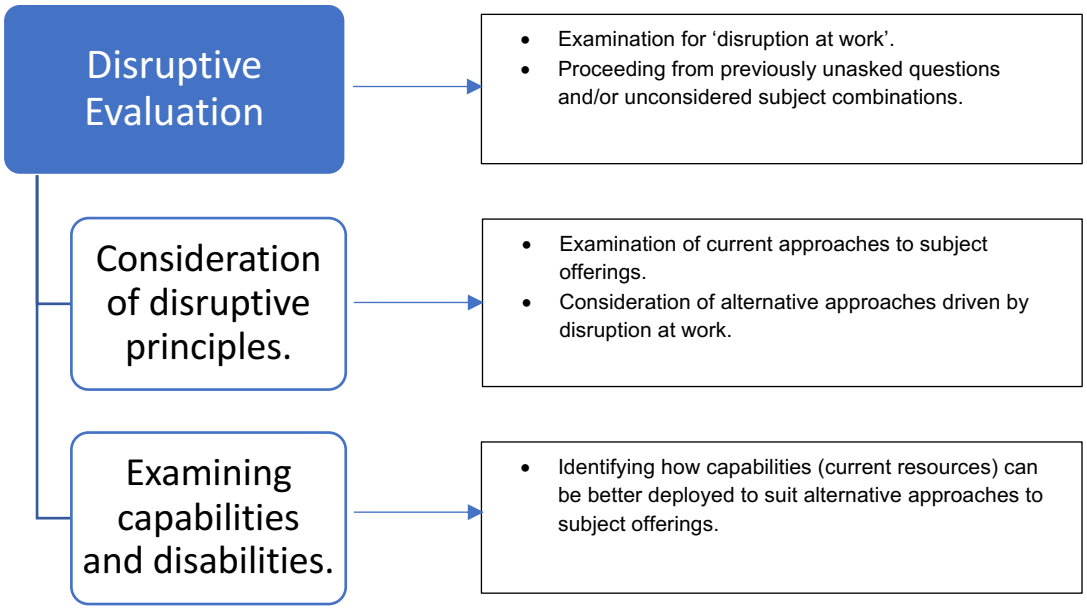


Figure 58 A model for schools. Component: Disruptive Evaluation

Figure 58 takes the insight gained from student perceptions (Figure 52) and applies the initial lens of disruption to consider current approaches and potential alternatives to subject offering. Operating at cohort level, the 'disruptive evaluation' component of the model for schools seeks to identify how subjects can be better arranged to suit the jobs that students are seeking to get done. At face value, this approach may simply appear as logical. However, this discussion emphasises that such an approach is driven by deeper understanding of students' perception of value and thus has the potential to improve outcomes. The available combination of subjects is not driven by the status quo of current capabilities. Rather the combination of subjects to be offered is informed by emerging insight deep from within student conceptualisation and value perception. Such insight could form the basis upon which schools consider whether new capabilities (resources, teaching staff) can or should be made available. The result of such consideration culminates in Figure 59.

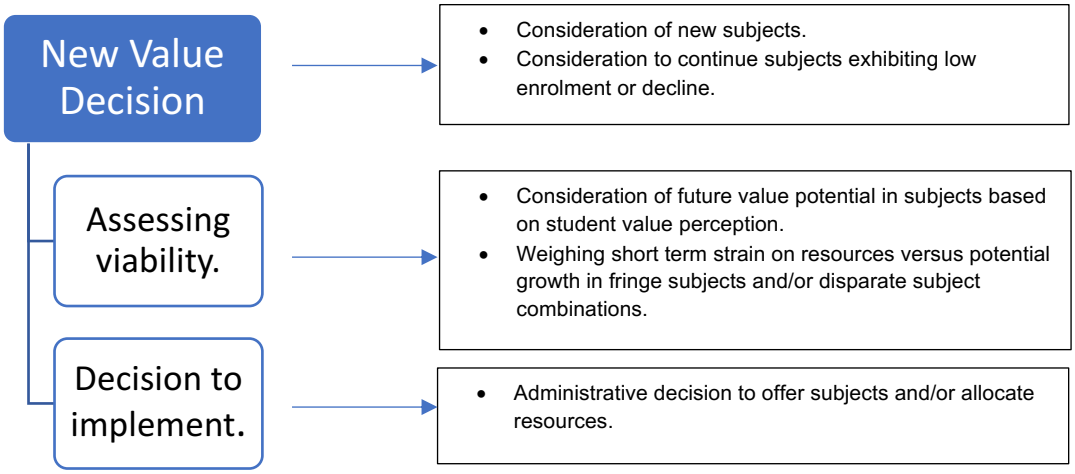


Figure 59 A model for schools. Component: New Value Decision

Figure 59 represents the most challenging component of the model for schools. This discussion acknowledges that implementation of the model for teachers and for schools requires investment and time as schools are unique and complex. It is not a 'plug and play' solution. Nor does the model for schools outlined in this discussion suggest that a disruptive approach is always appropriate. As stated, data presented in this research are meaningful in the context of the schools investigated. The participants in this study may benefit from disruptive approaches to subject selection that could be quite different from cohorts after them in following years. However early identification of disruption at work through enhanced knowledge of student conceptualisation and value perception could lead towards planning for sustainable strategies.

In summation of this discussion, the strategy statements below are based on the action statements produced when using the model for teachers with data from this study (see Chapter 5.3.2). They are hypothetical in nature and illustrate in couplet form how the model for teachers and schools can be used to influence strategic thinking. They are offered as examples and are not considered to be exhaustive.

Action statement

- Technology students have a strong desire to learn with practical tasks that are meaningful in the present and will continue to develop their future interests and pursuits in technology.

Strategy statement

- Technology subjects are delivered with practical experiences that reflect current and future trends in technology and align with student interests.

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Action statement

- Technology students bring with them a desire to design, make, and create as they consider building their skills for their vocation.

Strategy statement

- Technology subjects offer practical experiences that align with relevant vocational pursuits.

=======

Action statement

- Technology students are motivated by a desire to design and make for future global economic development.

Strategy statement

- Technology subjects are implemented in a global context, recognising, and respecting cultural context and diversity.

=======

Action statement

- Languages students aspire to learn language to contribute to improved future international relations.

Strategy statement

- Languages subjects are implemented with recognition of [Australia's] reliance on foreign relations and trade.

=======

Action statement

- Languages students are motivated to develop communication skills that help them build understanding between cultures.

Strategy statement

- Languages subjects are delivered with deep respect for meaningful communication between cultures, both local and globally.

=======

Action statement

- Languages students apply reason to connect acquired languages capabilities as a skill that they possess and can continue to refine.

Strategy statement

- Languages are promoted as a skill that can provide personal and professional benefit presently and throughout life.

5.5 The Conceptual Frame in Context

The conceptual frame for this study defined in Chapter 2.11 (Figure 60 below) was found appropriate for use with the data collection instrument of concept maps (Novak, 1995) and follow-up interviews. Student conceptualisation of the subjects they were studying was identified in participant responses. Proceeding from conceptualisation, relationships between connected elements on concept maps communicated propositions conveying specific meaning (Novak, 1995) and value. Themes were identified for concepts, relationships, and propositions in aggregate. However useful data were also identified which occurred only once (Drisko & Maschi, 2015) or in lesser volume.

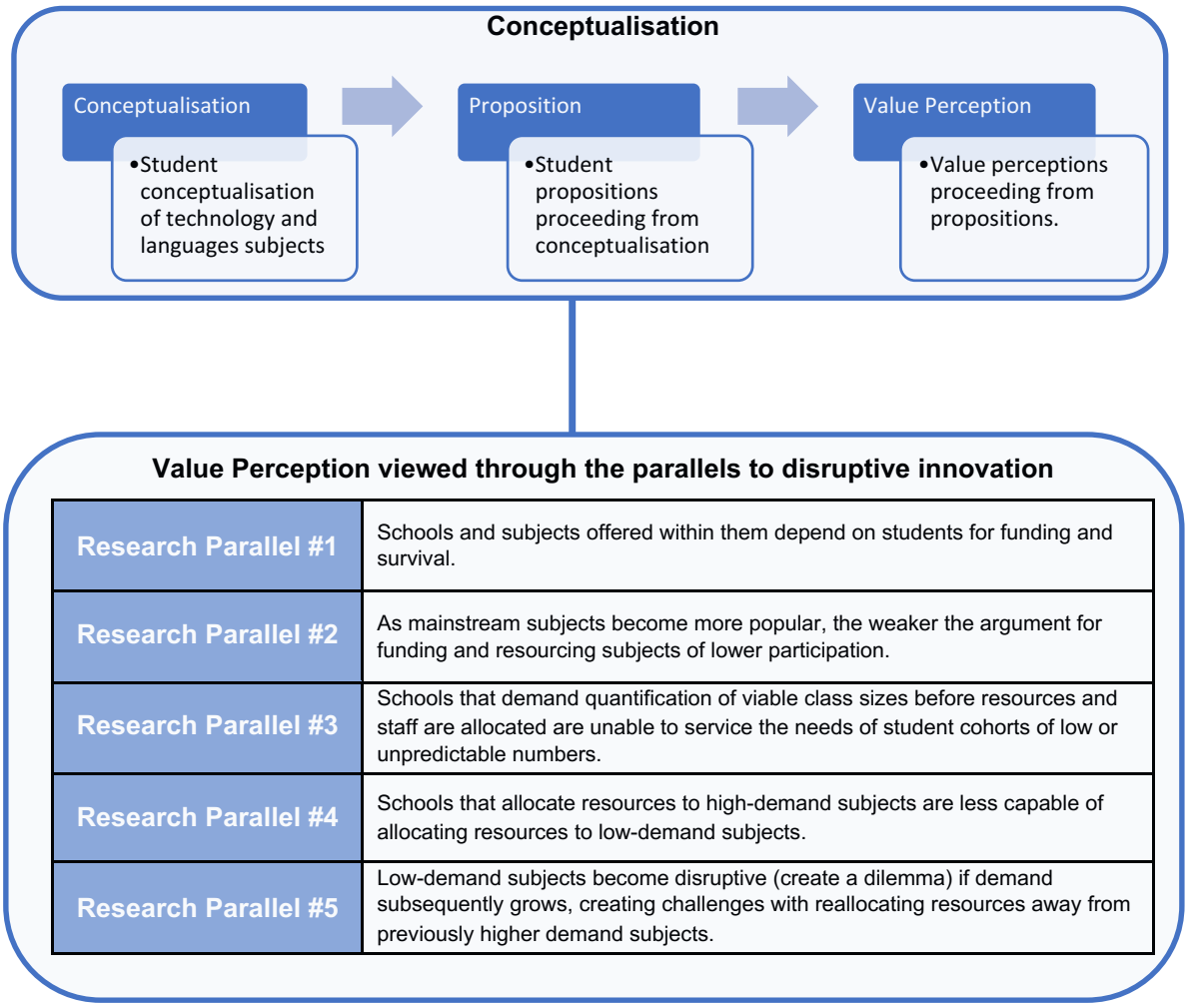


Figure 60 Conceptual Frame

The preceding discussion of findings as presented in this chapter illustrates how value perception in participant responses could be viewed through the parallels to disruptive innovation as described in Figure 60. The discussion highlighted how participants expressed propositions that indicated shifting perceptions of value and 'disruption at work' (see Chapter 5.4.1). Through conceptualisation and reconceptualisation, participants also communicated propositions that identified complementary value between technology and languages subjects as examined in this study (see Chapter 5.2.5). Proceeding from the discussion, it was possible to develop a 'model for teachers' (Chapter 5.3.2) and a 'model for schools' (Chapter 5.4.2). These models provide a basis for teachers and schools to consider student conceptualisation in the development of action statements and strategy statements. These statements can assist schools with planning sustainable strategies for subject resource allocation and provide guidance for students in subject selections. The data and findings presented in this study are meaningful to the research sites examined.

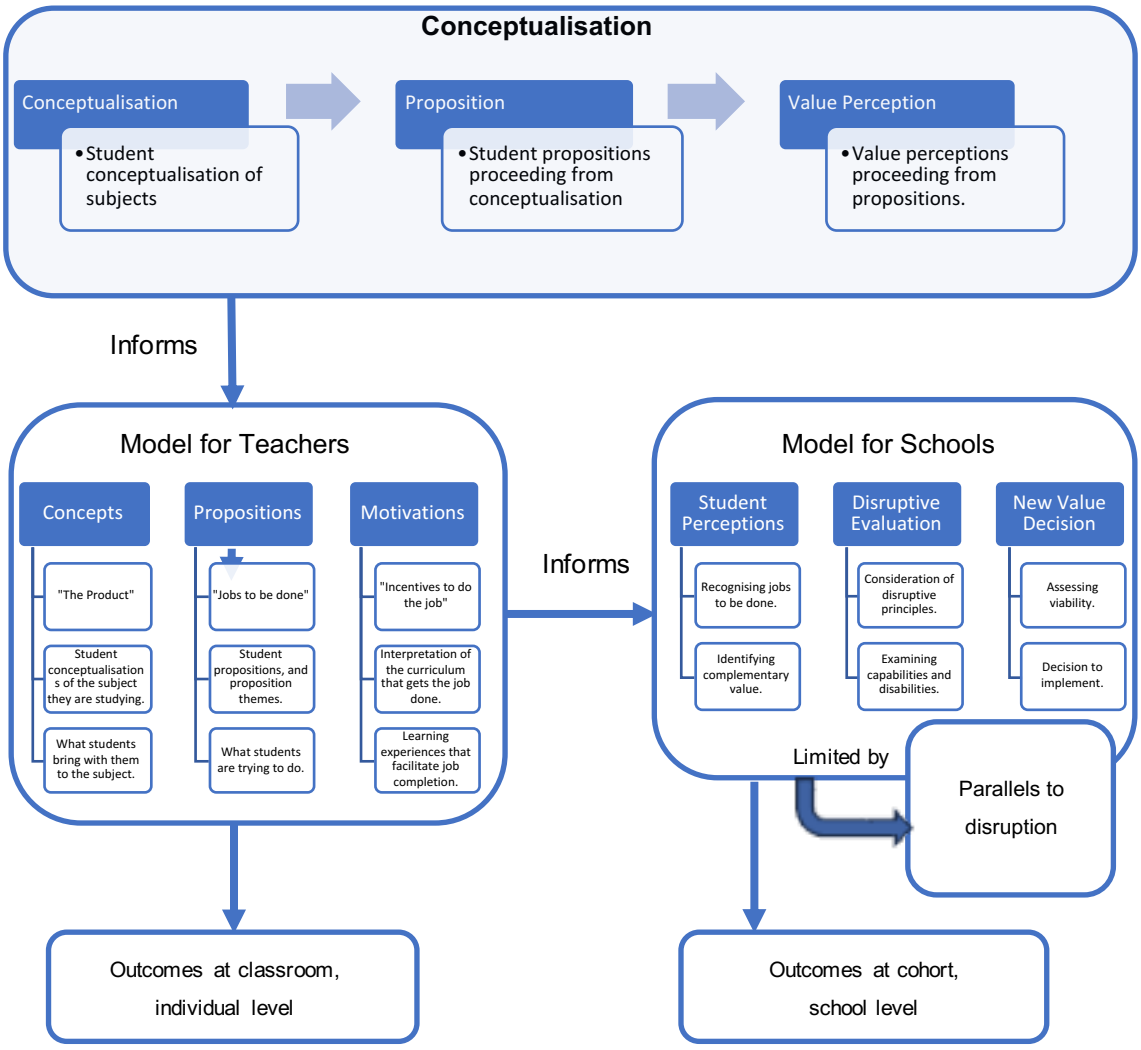


Figure 61 Conceptual Frame in Context

A final version of the conceptual frame, and one suitable for all schooling contexts that could be used in practice, is now illustrated in Figure 61. The conceptual frame in context retains the foundation of student conceptualisation of subjects to inform how teachers and schools can gain insight into the value perceptions and motivations of students. As such the Conceptual Frame in Context is a resulting output from this study, and as an approach, could be adopted by schools to produce meaningful data for school planning. The Conceptual Frame in Context does not intend to produce generalisable results.

Evidence of disruptive thinking may appear in student proposition statements. However, the frame indicates the parallels to disruption as limiting factors to the 'model for schools' since the decision to allocate resources to subjects lies with school administrators. Limiting factors notwithstanding, the proposal is that the conceptual frame illustrated in Figure 61 can be used by teachers and schools in unique contexts to improve outcomes.

CHAPTER 6: Conclusion

6.1 Mission Progress

Findings in this study, reported in Chapter 4 were preceded by a statement of mission made by the researcher. This study depicting technology and languages students' conceptualisations of their subjects and the value propositions found within them is borne out of actual events. Whilst not a participant in the study, the researcher was a character in the wider story being investigated. The researcher taught technology and languages subjects, which could be described as existing at the fringe of subjects available for students to elect, due to their lower enrolment numbers. The researcher witnessed and experienced the effects of declining enrolments in both subject domains. The concept of concurrently teaching across these two subjects appeared to be a natural fit to the researcher, however to others it was perceived as an unusual teaching combination. Given the challenges of lower participation in technology and languages subjects, and the resources required to staff and facilitate them, the over-arching question for this study centred around student conceptualisation of the subjects they undertake. For despite the annual challenges faced by subject departments in schools seeking elective student enrolments, students continue to enrol in them, signalling the possibility that students bring a conceptualisation of their subjects with them that influences their selection.

The notion that conceptualisation could influence subject selection suggests that students perceive value in their selections. The propositions offered by subjects arising from student conceptualisation could act as motivators for students to pursue such value. To ensure that teachers and students are aligned on the value present in their subjects, it would be beneficial for teachers to understand the way in which students conceptualise value and their motivation in selecting the subject. The extent to which value propositions influenced students to study technology and languages therefore became an underlying research question.

The consideration of the potential propositions for language subjects through the lens of technology students, and vice versa, also offered the opportunity to examine for complementary value between two types of subjects. The study was not conducted with a view that technology students should study languages, and vice versa. However, a presence of complementary value between the subjects could offer ways to identify new value in previously unconsidered subjects. Examining for complementary value in this study could provide insight for alternative approaches to constructing learning pathways for students as they progress through schooling and make elective subject choices.

The findings of this study suggest that the data collection method of concept maps (Novak, 1995), supported by follow-up interviews, resulted in data that address the research questions.

Participants conceptualised their subjects using visual and verbal communication that offered propositions conveying specific meaning (Novak, 1995). Propositions also offered a view into the value perceived by participants in their subjects which contributed to their motivation to study the subjects.

This conclusion begins with the position that the 'mission' stated in Chapter 4.1 has commenced. However, it is by no means complete as the data reported in this study are not broadly generalisable. The data collected in this study are rich and diverse, as noted in Chapter 4 Findings and Chapter 5 Discussion, and address the research questions. As the 'mission' is considered to be 'in progress', this conclusion first addresses the three research questions (RQs) and then discusses limitations and opportunities to extend the research based on aspects of the findings.

6.2 Conceptualisation is Active and Tangible – RQ1

Research Question 1 (RQ1) asks

- How do students conceptualise Technology and Languages subjects they study, independently from notions of assessment or curriculum?

It is pertinent to highlight that in this current study, participants could conceptualise their subjects without the researcher first explaining to them what 'conceptualisation' is or was meant to elicit. Engaging in conceptualisation, "the act or process of knowing" (Macquarie, 2024) came naturally to participants, as did the representation thereof through visual and verbal methods. To specifically address the 'how' of student conceptualisation in RQ1, participant responses must be considered through the lens of the data collection instrument of concept maps. As Novak (1995, p. 79) states, "fundamentally, a concept map is a way to represent the structure of knowledge".

This study shows that participants could 'structure' knowledge of their subjects independently from any notion of curriculum or assessment. That is, participants came to their subjects with a structure of some kind, rather than no structure. Participants represented the structure of their knowledge individually and the responses varied. However, all responses were consistent with the data collection instrument and were considered valid. The variation and consistency of responses resonate deeply with the method as described by Novak (1995) in the following statement.

> Since concept meanings derive from the context in which they were learned, culture and experience has an impact, so no two individuals conceive precisely the same meaning for any concept label.
> (Novak, 1995, p. 79)

The above statement is exemplified in the multiple concepts identified in participant responses. The identification of themes within the variations also made it possible to consider broader implications for educators as explored in the discussion in Chapter 5. Concept maps as used in this study are therefore consistent with the application of concept maps as described by Novak (1995, p. 82) who notes that “they [concept maps] can also be used to plan interviews, or for research or for teaching insights, and then serve as a kind of template to evaluate students’ understanding”. With respect to the ‘how’ as stated in RQ1, it can be said that participants in this study conceptualised their subjects in a manner that was diverse yet specific, rich, and detailed, and contained similarities that enabled useful thematic grouping. Such conceptualisation enabled an evaluation of students’ understanding (though not for assessment) and the identification of teaching insights leading to the development of a model for teachers and schools.

Further addressing the question of ‘how’ students conceptualise their subjects, this study shows that participants’ conceptualisation was not fixed. This finding further supports the use of concept maps as a reliable, valid, and objective data collection instrument for this study as participants could consider alternate value propositions and use those to consider alternatives for themselves. Such consideration reflects the use of concept maps noted by Novak who states that

> students might also construct concept maps of other domains of knowledge, such as how to learn meaningfully, or attitudes and values that are important in the learning of any subject matter”.
> (Novak, 1995, p. 84)

Participant reconceptualisation of their subjects in Phase 2 showed that participants were adept at considering alternatives and other domains of knowledge. This was particularly so for School A technology participants who expressed openness to considering a disparate elective subject choice (languages) in the context of a lacklustre technology learning experience (see Chapter 5.4.1). Such openness also elicited personal reflections by participants, triggered by the restrictions to learning that they experienced (see Chapter 5.3.3). Responses of this nature are also consistent with the data collection method as “concept maps can represent feelings and values as well as knowledge, if concepts are selected that express these ideas” (Novak, 1995, p. 84).

Amidst the conceptualisation recorded by participants, it was noted in the discussion (Chapter 5.2.1) that ‘innovation’ was not broadly conceptualised. In addition, conceptualisations of limitation imposed by gender, or cultural (including de-colonising) influences were also not broadly conceptualised. The absence of conceptualisations related to gender in this study is notable given that the iSTEM syllabus that School A participants were studying specifically “aims to increase the participation rate of female students” (NSW Department of Education, 2021, p. 8). The absence of gender references by School A participants is likely influenced by the lack of female participants at School A. However, Schools B and C included female students in technology subject offerings and no references to limitations or prejudice based on gender were identified in participant responses. Literature examined in Chapter 2 suggests that limitations can exist in the language particular to a subject domain. Such language can influence perceptions of ability within the subject (such as IQism) (Collier et al., 2016; Xie et al., 2015), and also impact educators’ ability to communicate effectively with students from varied linguistic or cultural backgrounds (Charity Hudley & Mallinson, 2017). Data collected at Schools A, B, and C did not suggest that any factors of ‘language’ particular to the subject domain presented challenges to learning based on cultural, intellectual, or gender factors.

Despite the lack of cultural or gender-based limitations recorded in participant responses, this study cannot conclude that such factors do not exist in other contexts. Whilst the schools researched in this study are regionally diverse and separated by wide distances (hundreds of kilometres), they are similar in socio-economic demographic and type (independent coeducational Christian schools). This study also cannot conclude that such factors were not present at the schools researched since participants were not presented with focus questions targeted towards gender or culture. The study noted in Chapter 2 by Rainey et al. (2018) resonates at this point whereby data in this research could potentially be considered as appropriate only for similar independent coeducational Christian schools. This research concludes, however, that such similarity is not considered to devalue the conceptualisations identified in this study. Rather, it provides the potential to extend the research by including the intersectionality of further factors, such as gender and culture, across other school contexts.

Conceptualisation as shown by participants in this study can therefore be described as active and tangible. Participants communicated conceptualisation clearly and not with vague or nebulous descriptions of the subjects they were studying. The conceptualisations recorded by participants addressed RQ1 and were foundational to the relationships and propositions that further informed the two further research questions, RQ2 and RQ3.

6.3 Value Perception is Specific, Broad, and Motivational - RQ2

Research Question 2 (RQ2) asks

- To what extent did value propositions presented by those subjects, and resulting from the conceptualisation strategy, motivate students to study those subjects?

Proceeding from conceptualisation investigated in RQ1, participant responses communicated relationships between concepts and propositions offered by their subjects. Proposition statements recorded on concept maps enabled the investigation of how those propositions may influence or motivate students to select those subjects. Such investigation addresses RQ2 and explores the objective of 'opportunity' stated in Chapter 1.5 Research Questions. The objective was developed to determine how participants identify value in their subjects. The way value is identified could uncover new perceptions of value as held by participants and provide opportunities to teachers to modify classroom practice based on such insight. Conceptualisation was used as a basis from which further insight could be drawn as participants expanded upon the concepts underpinning their subjects and what value factors influenced their decision to study them.

The consideration of value, and where new value may exist created the entry point for the disruptive innovation component of the conceptual frame in Chapter 2.11 to be applied. The five underlying principles of disruptive innovation (Christensen, 2013, p. xix) outlined in Chapter 2.9 were placed in parallel by the researcher to facilitate the examination of value and motivation (as described in Chapter 5.3.2) perceived by participants, and how that could be used to address the dilemma faced by schools outlined in Chapter 1.0 Introduction.

Data collected in this study show that participants could communicate relationships between conceptual elements in the subjects they were studying. The relationships communicated by participants led to the formation of proposition statements about their subjects. The propositions were diverse, however also similar enough such that they could also be grouped into themes across the three schools. Of the 19 themes identified across Schools A, B, and C (discussed in Chapter 5.3.1) only one theme indicated a perception of negative value; the theme of 'frustration'. The remaining themes communicated some form of value ranging from 'value perception' specifically, to learning, cognitive, cultural, relational, economic, or vocational benefit. The data presented specific and broad responses reflecting what 'jobs' participants considered the subjects could do for them. Specific responses about learning skills and techniques (in the present) were extrapolated into the potential careers or vocational pursuits (in the future) that participants considered. The data in this study do not support a notion that participants were simply recipients of the curriculum delivered to them. Whilst 'value' was not measured quantitatively, this study concludes that there is a meaningful extent to which value propositions presented by the subjects being studied motivated students to select them. Moreover, this study concludes that such meaningful 'extent' can be used for positive effect

through the development of a ‘model’ or approach to sustainable improved outcomes for both teachers and school administrators.

Whilst proposed models for teachers and school administrators are discussed in Chapters 5.3.2 and 5.4.2 respectively, this study declares an important caveat. The models discussed are explored with examples from data in this study and consider the research parallels to disruptive innovation as stated in the conceptual frame. However, this study does not conclude that a disruptive approach is appropriate in every context as individual schools are unique and complex. The models are also proposed for use within schools and not across schools. That said, the models may provide the basis for fruitful discussion between schools where collaborative cooperation seeks to discover solutions to challenges with resource allocation.

It can be said of the data and the themes described above that the ‘extent’ to which value propositions influenced participant subject selection is broadly positive. However, like the caveat declared above, it must also be concluded that an examination such as that carried out in this study can also reveal unfavourable results. Rather than ‘to a meaningful’, or ‘to some’, or ‘to no’ extent, the data collected in this study also revealed what can be described as ‘to a negative’ extent.

Labelled as a ‘restrictive juxtaposition’ in Chapter 5.3.3, the communication of frustration by participants by the limitation of their experience is noteworthy. This study aligns with principles of qualitative content analysis as described by Drisko and Maschi (2015) whereby data appearing only once, or in lower volume, is still considered important.

This conclusion draws attention to the above point due to its close relationship to the first principle of disruptive innovation outlined in Chapter 2.9. The first principle of disruptive innovation states that “companies depend upon customers and investors for resources” (Christensen, 2013, p. xix). Paralleled to this first principle, Research Parallel 1 (RP1) states that schools and subjects offered within them depend on students for funding and survival. RP1 speaks to the restrictive juxtaposition identified in this study. Despite only appearing for technology participants at Schools A and B, participant responses indicated high expectations of value that were not fulfilled. The unfulfilled expectations of value led to what could be described as generating negative sentiment amongst participants. Notably, such sentiment did not detract from participants’ completion of the data collection task. Participants did not use the data collection task to express disappointment through non-completion of the task. Rather, they embraced the opportunity to express themselves. Participant disappointment through value not experienced was clearly communicated. However, during their schooling, participants continued attending their chosen subjects, potentially due to lack of viable alternatives or inability to switch subjects. Participants therefore found themselves in an awkward and restrictive juxtaposition. This study concludes that such a situation is meaningful (albeit disappointing) to participants.

Moreover, that knowledge of such disappointment can be useful to educators for facilitating more effective student learning experiences.

This study showed that participants could identify value propositions in the subjects they were studying. Examples including conceptualisations of future careers in the military coupled with proposition statements of ‘reason I joined’ (School A, Phase 1) indicated that such value motivated participants to study those subjects. The ‘extent’ of such motivation was covered by a broad range of factors expressed by participants including specific skills and abilities to wider vocational or societal impacts. Those outcomes were expressed in the context of present and future value. Whilst the ‘extent’ was not measured quantitatively, it can be concluded that there is a relationship between value and motivation evident in the data, and that knowledge of this relationship can be beneficial to educators. There is no evidence to suggest that participants expressed ‘no value’, or that they were enrolled in the subjects due to a lack of preferable alternatives. The presence of negative sentiment as described above suggests a communication of ‘no value’, however it is important to note that the value was at first expected, but then not experienced. At this point, the model for teachers described in Chapter 5.3.2 may assist schools to avoid negative sentiment at the outset through a clearer understanding of student expectation and subject offering.

6.4 Complementary Value: A Disruptive Foothold – RQ3

Research Question 3 (RQ3) asks

- To what extent do complimentary value propositions between languages and technology subjects exist, and how do students express this?

After this study’s investigation of conceptualisation (RQ1), and value proposition and motivation (RQ2), the relationships between conceptualisation and propositions also enabled the examination of complementarity between technology and languages subjects. It is reiterated that this study does not suggest that technology participants should study languages, or vice versa. Rather, the examination for complementarity explores the objective of ‘understanding’ as stated in Chapter 1.5 Research Questions. By presenting the propositions of technology and languages participants to the alternate participant cohorts (technology to languages, and languages to technology), it was possible to examine for overlapping value propositions. Potential synergies between the subjects (or lack thereof) could then be considered. This study concludes that complementary value propositions do exist for the participants, and that there are implications for schools when viewed through the conceptual frame outlined in Chapter 2.11.

Complementary value between technology and languages subjects was examined through the relationships between conceptual elements recorded by participants on concept maps. With respect to the 'extent' of complementary value existing in participant responses, findings reported in Chapter 4.4 broadly indicated shifting perceptions of value for technology and languages participants. Technology participants gained increased awareness of technological activity and outputs on individuals and society, both in local and wider global contexts. Languages participants' responses included a reframing of foreign languages acquisition as a 'skill', similar to how technology participants expressed their desire to learn and acquire practical skills in designing, solving, creating, and making. A conclusion could therefore be drawn that given the opportunity to consider alternative value propositions, students can alter their perception of value in the subjects they undertake. Whilst such a shift in perception is not a 'disruptive' innovation or technology, this research proposes that disruptive thinking can gain a foothold when alternative propositions are presented to students. Understanding why students would engage in such thinking has implications for school administrators as discussed in Chapter 5.4.2.

The School A follow-up interview dialogue discussed in Chapter 5.4.1 highlighted that participants generally valued a more structured teaching and learning environment rather than being given too much freedom. The notion of goal setting, and the negative sentiment of not achieving goals was clearly evident in responses. Such responses suggest a strong sense amongst participants that the subject they are studying should do something for them, i.e., a 'job'. Moreover, that if the subject cannot do the job, then an alternative is more desirable. As noted by Christensen et al. (2010, p. 168), "consumers [or students] demonstrate daily the propensity to prioritise what they want to accomplish, not what they are told they should accomplish". The objective of 'understanding' becomes pertinent at this point. Improving the subject experience may not assist the student to achieve intended goals if the outcomes of the subject are poorly matched with what the student wishes to accomplish. School A technology participant responses exemplify this dynamic. Responses indicated that technology outcomes may not have entirely represented the 'job to be done' by the i-STEM subject that participants were studying. When questioned about interest in a languages subject as an alternative, it became apparent that School A technology participants placed greater value on a structured learning environment over the freedom they were experiencing in i-STEM. Moreover, that they perceived a languages subject could offer them such a structured environment.

The value placed on learning over freedom discussed above suggests a willingness by participants to consider alternatives rather than remain idle. Such willingness is not considered to be a disruptive 'innovation' or 'technology'. However, this study concludes that if students are presented with compelling alternatives to a subject that does not do the required 'job', alternative subjects previously not considered by the student could be viewed with higher value. Although such a conclusion may seem simplistic or obvious, the distinction made here is that

subject selection with disruptive thinking leans more towards the job to be done as perceived by the student, rather than what the content of the subject offers. Such a consideration is described in this research as an entry point for raising 'disruptive awareness' amongst students.

With respect to how students 'express' complementary value propositions between technology and languages subjects, the data show that participants could reconceptualise their subjects and identify complementary value. Complementarity was evident in drawn responses on concept maps and in follow-up interviews. However, such data mostly occurred in Phase 2 data collection once participants had been exposed to the propositions collected from the alternate cohort. An exception exists with School A technology participants where complementary value and 'disruptive thinking' became evident in the Phase 1 follow-up interview. The consideration of complementary value proceeded from the semi-structured nature of the interview whereby the researcher had the opportunity to raise the question. This study concludes, however, that participants were unlikely to express knowledge or awareness of complementary value unless prompted or provided with specific examples to respond to, such as those in Phase 2 focus questions.

The notion that students can identify value propositions in subjects that they are not currently studying provides an opportunity to school administrators. An 'understanding' of why students would perceive such alternative value can help schools to leverage an approach to resource allocation as suggested in the model for schools in Chapter 5.4.2. However, this study proposes that such leverage can only be applied if the understanding is gained from the students within the local context. As stated, the concept maps recorded in this study produce data that are unique and that "concept meanings derive from the context in which they are learned" (Novak, 1995, p. 79).

This study concludes that conceptualisation and propositions proceeding therefrom can assist schools to acquire data that can facilitate the consideration of value propositions in alternative subjects. Such consideration may assist students to broaden their scope for subject selection based upon a clearer understanding of how subjects can meet their intended goals. A wider consideration of subjects by students may then assist schools in decisions to consolidate resources into fewer subjects or increase resources to subjects of lower enrolment.

6.5 Methodological Applications

With its foundation in research, Novak (1995) states that concept mapping can also be used to "significantly help teachers in planning instruction, as well as aiding authors in planning textbooks, and learners in organising their learning" (p. 79). This study supports the application of that statement as evidenced by the richness of concept maps reported in Chapter 4 Findings.

As noted in Chapters 4.2, 4.3, and 4.4, concept maps presented with broad consistency such that they could be used for the identification of concepts, relationships, and propositions. However, the diversity amongst the responses also provided insight into variations of how participants interpreted both the task and the conceptualisations of their subjects. Participants were provided with examples of typical concept maps as stimulus for the task and instructed that they could depart from the samples if they considered it more helpful to construct their response. Participants were also reminded that the concept mapping task was not assessing their knowledge of the subject. It is likely that the freedom to depart from the typical structure, and the non-assessable nature of the task removed an element of pressure for participants. Concept maps were produced individually although in a group context. Participants could see the responses of other participants adjacent to them but not those of others seated further away. Completed concept maps were not shared with the groups in which they were created. However, follow-up interviews were conducted in groups and responses were therefore audible by all participants. In that context, all responses were unique in their structure with no evidence of 'copying' another response. It is speculated that such an environment contributed to the diversity of responses ranging from simple linework and text, to highly creative responses displaying use of colour and sketched images to complement the content.

In addition to the applications noted by Novak (1995) above, this study suggests that the diversity and creativity presented by participants creating concept maps could be used to gauge what may be described as the 'character landscape' of a group of students. It is suggested that a deeper awareness of the character, or personality, behind student propositions could further assist teachers in 'understanding' student motivation and expectation of the subject. Examples from the data include the connection with French and the performing arts (School B Languages) and the strong conceptualisation of the 'military' (School A Technology). Teacher knowledge of such predisposition in students could assist with or influence how teachers deliver the subjects. Any evidence of character, or personality, was a product of the grounded nature of the study and not intended for examination. However, the presence of such evidence could provide an opportunity to extend this research.

This study utilised the concept mapping method to examine student conceptualisation of their subjects and the propositions and value perceptions held by students about those subjects. With respect to planning instruction, as noted above, the data collected in this study suggest that the concept mapping method could be used to survey students for potential approaches to content delivery. The strong conceptualisation of the 'military' in responses from School A Technology participants is a pertinent example. It is not suggested that such responses should alter the curriculum content. Rather that knowledge of student predisposition to the military (in the context of School A Technology participants) can provide meaningful inspiration to teachers to adjust or explore curriculum content with a military focus. It is acknowledged that other themes could be strongly represented in the whole class cohort since not all i-STEM students

from School A opted in to participate in the study. However, surveying the whole class using concept maps could yield insight into the stronger themes present in student conceptualisation. Such insight could inform how teachers proceed with delivery of subject content and how learning experiences could be varied to suit the current cohort.

The methodological application of concept mapping for planning instruction described above requires investment of time that could otherwise be used for delivery of content. This study recognises that allocating such time may not be practical or possible in some contexts. The benefit of such an exercise could therefore be called into question given limited time and resources. However, given the rich nature of the data collected in this study, an opportunity exists to extend this research by surveying teachers. Teachers could complete a concept mapping task with students and the perceived benefits (or lack thereof) could be examined with respect to planning instruction. Insight could also be gained on the cost/benefit relationship with respect to the time and resources required to complete such a task.

6.6 Limitations

Data were collected across Schools A, B, and C between September 2020 and May 2021. During this time, the COVID-19 pandemic created significant challenges in accessing schools for data collection. A remote data collection method was developed and approved by the university ethics committee; however participating schools all preferred onsite data collection. Strict COVID-19 protocols implemented by the schools and the researcher were adhered to. It is uncertain as to whether the pandemic affected participant numbers due to a perception of increased risk from visitors to the schools. It is possible that conducting the same study in a post pandemic period could attract a larger number of participants. However, the total number of participants (40 across three schools, plus one teacher) was considered sufficient for the study.

A factor related to the pandemic that is likely to have impacted participant perception is access to teachers, resources, and equipment. This is particularly so for technology participants. Lockdowns prevented technology participants from accessing school workshops which negatively impacted their ability to engage in practical projects or receive direct instruction on practical tasks from their teachers. It is acknowledged that such a situation is sub-optimal for students who are motivated to work in practical sessions, given that they are unlikely to have access to similar equipment or workshop spaces while working from home. School A Technology participants explicitly cited COVID as a challenge for their new teacher in addition to the burden of making the transition to a new school and teaching new students (School A Phase 1 follow-up interview, timecode 23:14, Appendix I). In addition, School A Technology participants also noted that time spent working on projects was unduly extended due to COVID

‘interruption’ (School A Phase 1 follow-up interview, timecode 23:58, Appendix I). It is likely that responses would have been different if the impacts of COVID had not existed. However, it is uncertain as to whether responses would have been generally more positive or negative. Challenges also existed for languages participants in that access to their teachers during the pandemic was restricted to online learning. It is uncertain as to how languages participants’ responses would have differed in the absence of pandemic-related challenges.

This study used an opt-in method for attracting students to participate. The invitation was also extended to the teachers of those students. Of the six possible teacher participants, only one of the technology teachers at School B participated. The low teacher participant numbers did not negatively impact the outcome of the study since the research questions were primarily aimed at investigating student conceptualisation, value perception, and the factors that motivated students to select their subjects. However, responses from all potential teachers could have yielded insight into how and whether teacher conceptualisations are aligned with student conceptualisations. As an example, participation by the additional technology teacher at School B, and the technology teacher at School A could possibly have identified whether there was any awareness of restriction imposed upon students, either by the pandemic or the delivery of the subject generally. The addition of further teacher participants creates an opportunity to extend this research. Such extension could involve examining only teacher conceptualisations and their perceived value of the subjects for students. Alternatively, the present study could be extended by asking the same questions of students, and modified questions for teachers. Focus questions for teachers would be modified to examine their perceived value for students. Such a line of enquiry could uncover insight as to whether teachers’ and students’ perceptions are aligned on what jobs the subjects can do for students.

Further to the limitation of restricted access to workshops spaces noted above, equipment available to students in any given context can vary. Variations in available tooling, machinery, or the physical space itself can result in differing capacities to produce projects. This is exemplified in the i-STEM syllabus studied by School A Technology participants. Teachers are permitted to make adjustments to curriculum implementation based on available resources and expertise of teaching staff. For School A during the time of data collection, such adjustments were made through the selection of appropriate electives within the course where the decision is “up to the school, based on teacher knowledge, timetabling and school preference” (NSW Department of Education, 2021, p. 9). A similar core and ‘electives’ structure exists in the revised STEM syllabus currently in use (NSW Department of Education, 2023). There was no evidence in the data to suggest that participants perceived a lack of opportunity based on resources available at their schools relative to those of others. An opportunity to extend the research in this study exists to examine for perceptions of inequity based on local resources or expertise to effectively deliver the course.

Languages participants face a limitation in resources and choice based upon the language capability of available teaching staff. There were no School A Languages participants as there were no year 9 or 10 languages classes currently being offered due to lack of enrolments. It is noteworthy that the lack of languages classes was raised by School A Technology participants in follow-up interviews where limited languages choices and a lack of qualified teachers were cited (School A Phase 1 follow-up interview, timecode 25:13ff). A similar dynamic was noted in the study by Black et al. (2018). School A was limited to French in the mandatory Stage 4 (year 7 & 8) course, whereas Schools B and C could offer more choice. A notion of limitation was recorded in School A participant responses, however there was no evidence in School B and C responses that participants felt limited in their choices for languages study. The lack of School A Languages participants is a limitation of this study and speaks to the challenges faced by languages as a subject area at that school. An opportunity exists to extend this research at a future data at School A when sufficient enrolments are present to offer a Stage 5 (year 9 & 10) languages subject.

The schools investigated present an element of limitation to this study. The schools are similar in that they are independent coeducational K-12 Christian schools and draw student populations of similar socio-economic demographic. The schools were chosen for their similarity and for the ability to access them. It is acknowledged that such an approach to selection may generate a perception that findings are particular to participant populations of that type, similar to the dynamic identified by Rainey et al. (2018). However, the selection of schools is considered both a strength of the study and an opportunity to extend the research. This study does not propose that the data are specific to schools of the type selected, for as previously stated, findings from this study are not considered to be broadly generalisable. Rather, the proposal is that findings are considered unique in each context and conclusions drawn are applicable for those participants, in those schools. The model for teachers and schools (Chapters 5.3.2, 5.4.2 respectively) emphasise and operationalise such a proposal. The opportunity to extend this research therefore lies in conducting this research in schools individually, independent of the type, system, or socio-economic demographic of the school population. An extension of this nature would build upon the unique nature of student conceptualisation (Novak, 1995) to develop locally beneficial outcomes.

6.7 Recommendations

This study is placed in the context of curriculum reform, innovation, and the calls for greater participation and performance in technology and languages. The challenges facing technology and languages subjects due to declining enrolments create a dilemma for school administrators to continue resourcing and staffing those subjects, or other subjects that face similar challenges. Yet students continue to enrol in those subjects. Findings in this study suggest that

the dilemma will continue for school administrators as students communicated a strong sense of present and future value in their subject selections. Value propositions were derived from the relationships between conceptual elements of technology and languages subjects identified by participants. The communication of conceptualisation, value and motivation was clear and unambiguous. Since the conceptualisations were communicated independently of curriculum or assessment, this study recognises that students are unlikely to come to their subjects absent of any concept of, or expectation for what their subjects need to 'do' for them, or help them achieve. In the first instance, this study recommends that gaining awareness of the salience of such conceptualisation can be of great assistance to schools in addressing the stated dilemma.

With respect to innovation, participant responses in this study did not identify a strong sense of the need for greater innovation in technology or languages subjects. As discussed in Chapter 5.2.1, it is not suggested that participants were in classes which lacked innovative teaching practices. However, the reasons as to why innovation is not conceptualised by students within or across subjects could open avenues for further research. The absence of communication by participants about the need for innovation suggests that other more dominant conceptualisations are considered more valuable. As discussed in Chapter 5.2.2, the theme of 'learning' presented as a key conceptualisation across all participants. Moreover, that 'learning' was preferable to 'no learning' or increased freedom. Such a dynamic opens the opportunity for schools to introduce what this study describes as 'disruptive thinking', whereby students begin to consider possibly disparate alternatives when the subjects they are studying are not helping them to achieve their goals. Shifting conceptualisations of subjects occurred in this study when participants were presented with propositions offered by participants in the alternate cohort. Since the subjects of technology and languages are considered disparate, the reconceptualisation of subjects by participants indicated a willingness to consider markedly different alternatives to facilitate their learning.

This study identified the willingness and ability of students to reconceptualise notions of value in their subjects by considering propositions of value held by students in disparate subjects. Such reconceptualisation occurred within concept map and follow-up interview responses which communicated a desire to learn and achieve present and future goals. Disruptive thinking in this context is represented by the participant's consideration of alternatives to their current subject selection to achieve their goal (get a job done). Such thinking was not present in all responses, however the occurrences where it was evident did suggest that participants would consider choosing less considered alternative subjects if their learning could be better facilitated. A focus on subject improvement, or innovation per se was not communicated by students as a means to such facilitation.

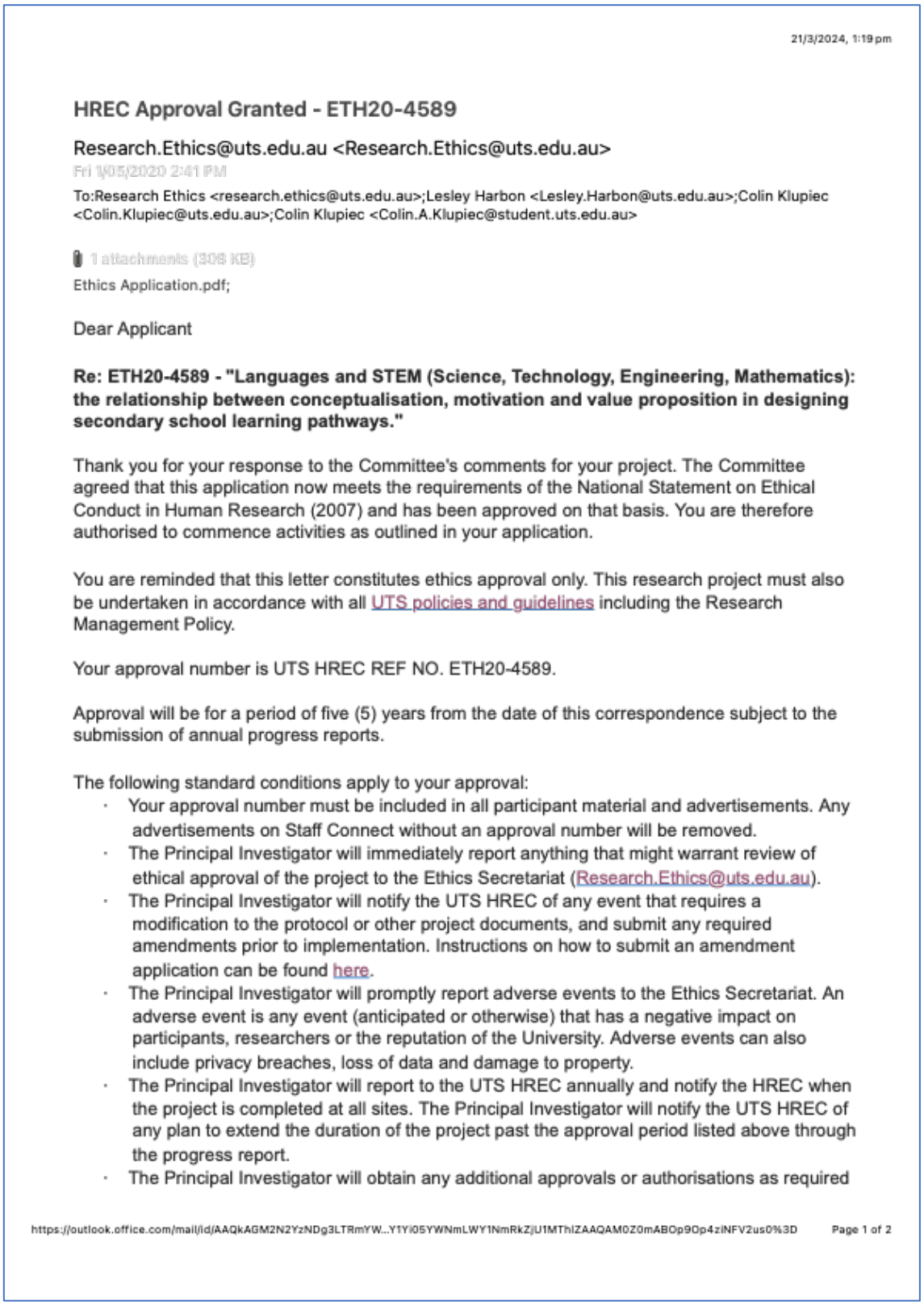
Implementation of the models described in the discussion offer an approach to surface data that can assist teachers and schools to develop alternative strategies. The models are not intended

to create generalisable data, however insight gained could produce fruitful discussion amongst schools facing similar challenges. Since the model for schools recognises the limiting factors imposed by the influence of disruptive innovation, it is acknowledged that a disruptive approach may not always be appropriate. However, the conceptualisation obtained through the model for teachers which informs the model for schools may still surface unique insight about student cohorts that can be of assistance to teachers in subject planning and delivery. New value may not necessarily emerge from a focus on, or preconception of the need for innovation or 'improvement'. In some cases, new value may appear from previously unconsidered, or discarded alternatives.

This study recommends that knowledge of student conceptualisation and value perception in the local context can inform effective subject delivery and assist students in subject selection. The methods employed in this study can surface data that may help shift the thinking of educators. A shift that could place increased emphasis on the 'job' that students are trying to get done, alongside the importance of the content of the curriculum itself. A clearer view of what students are trying to achieve may assist schools to identify how current resources are deployed, where they may be misplaced, and where opportunities for new value may occur.

Appendices

Appendix A – Ethics Approval ETH20-4589



21/3/2024, 1:19 pm

HREC Approval Granted - ETH20-4589

Research.Ethics@uts.edu.au <Research.Ethics@uts.edu.au>
Fri 1/05/2020 2:41 PM
To:Research Ethics <research.ethics@uts.edu.au>;Lesley Harbon <Lesley.Harbon@uts.edu.au>;Colin Klupiec <Colin.Klupiec@uts.edu.au>;Colin Klupiec <Colin.A.Klupiec@student.uts.edu.au>

1 attachments (308 KB)
Ethics Application.pdf;

Dear Applicant

Re: ETH20-4589 - "Languages and STEM (Science, Technology, Engineering, Mathematics): the relationship between conceptualisation, motivation and value proposition in designing secondary school learning pathways."

Thank you for your response to the Committee's comments for your project. The Committee agreed that this application now meets the requirements of the National Statement on Ethical Conduct in Human Research (2007) and has been approved on that basis. You are therefore authorised to commence activities as outlined in your application.

You are reminded that this letter constitutes ethics approval only. This research project must also be undertaken in accordance with all UTS policies and guidelines including the Research Management Policy.

Your approval number is UTS HREC REF NO. ETH20-4589.

Approval will be for a period of five (5) years from the date of this correspondence subject to the submission of annual progress reports.

The following standard conditions apply to your approval:

- Your approval number must be included in all participant material and advertisements. Any advertisements on Staff Connect without an approval number will be removed.
- The Principal Investigator will immediately report anything that might warrant review of ethical approval of the project to the Ethics Secretariat (Research.Ethics@uts.edu.au).
- The Principal Investigator will notify the UTS HREC of any event that requires a modification to the protocol or other project documents, and submit any required amendments prior to implementation. Instructions on how to submit an amendment application can be found here.
- The Principal Investigator will promptly report adverse events to the Ethics Secretariat. An adverse event is any event (anticipated or otherwise) that has a negative impact on participants, researchers or the reputation of the University. Adverse events can also include privacy breaches, loss of data and damage to property.
- The Principal Investigator will report to the UTS HREC annually and notify the HREC when the project is completed at all sites. The Principal Investigator will notify the UTS HREC of any plan to extend the duration of the project past the approval period listed above through the progress report.
- The Principal Investigator will obtain any additional approvals or authorisations as required

https://outlook.office.com/mail/id/AAQkAGM2N2YzNDg3LTRmYW...Y1Yi05YWNmLWY1NmRkZjU1MThlZAAQAM0Z0mABOp9Op4ziNFV2us0%3D Page 1 of 2

(e.g. from other ethics committees, collaborating institutions, supporting organisations).

- The Principal Investigator will notify the UTS HREC of his or her inability to continue as Principal Investigator including the name of and contact information for a replacement.

This research must be undertaken in compliance with the Australian Code for the Responsible Conduct of Research and National Statement on Ethical Conduct in Human Research.
You should consider this your official letter of approval. If you require a hardcopy please contact the Ethics Secretariat.

If you have any queries about your ethics approval, or require any amendments to your research in the future, please don't hesitate to contact the Ethics Secretariat and quote the ethics application number (e.g. ETH20-xxxx) in all correspondence.

Yours sincerely,

A/Prof Beata Bajorek

Chairperson

UTS Human Research Ethics Committee

C/- Research Office University of Technology Sydney

E: Research.Ethics@uts.edu.au

Ref: E38

Appendix B – Ethics Approval ETH20-5359 for additional School C

UTS HREC Approval - ETH20-5359

Research.Ethics@uts.edu.au <Research.Ethics@uts.edu.au>
Wed 14/10/2020 6:02 PM

To:Research Ethics <research.ethics@uts.edu.au>;John Buchanan <John.Buchanan@uts.edu.au>;Colin Klupiec <Colin.A.Klupiec@student.uts.edu.au>;Lesley Harbon <Lesley.Harbon@uts.edu.au>;Colin Klupiec <Colin.Klupiec@uts.edu.au>

1 attachments (183 KB)
Ethics Application.pdf;

Dear Applicant

Re: ETH20-5359 - "Languages and STEM (Science, Technology, Engineering, Mathematics): the relationship between conceptualisation, motivation and value proposition in designing secondary school learning pathways."

The Human Research Ethics Executive Review Committee reviewed your amendment application for your project and agreed that the amendments meet the requirements of the NHMRC National Statement on Ethical Conduct In Human Research (2007). I am pleased to inform you that the Committee has approved your request to amend the protocol as follows:

"I wish to approach additional schools in my region to participate in the study. I wish to use a short video that I can provide to schools when I make initial email contact with them."

This amendment is subject to the standard conditions outlined in your original letter of approval.

Additionally, this amendment is subject to the following special conditions:

1. Evidence of support from schools should be provided.

You are reminded that this letter constitutes ethics approval only. This research project must also be undertaken in accordance with all UTS policies and guidelines including the Research Management Policy.

You should consider this your official letter of approval. If you require a hardcopy please contact the Research Ethics Secretariat.

To access this application, please click here, a copy of your application has also been attached to this application

If you wish to make any further changes to your research, please contact the Research Ethics Secretariat in the Research Office.

In the meantime I take this opportunity to wish you well with the remainder of your research.

Yours sincerely,

The Research Ethics Team
on behalf of the Human Research Ethics Executive Review Committee
C/- Research Office
University of Technology Sydney
T: (02) 9514 2478
Research.Ethics@uts.edu.au | Website
PO Box 123 Broadway NSW 2007

Ref: E13-3

Appendix C – Participant Consent Forms

Common to all research sites.

UTS UNIVERSITY OF TECHNOLOGY SYDNEY

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UTS CRICOS PROVIDER CODE 00099F

CONSENT FORM – Students

Languages and STEM: the relationship between conceptualisation, motivation and value proposition in designing secondary school learning pathways
HREC No.: ETH204589

I _____ *[participant's name]* agree to participate in the research Languages and STEM: the relationship between conceptualisation, motivation and value proposition in designing secondary school learning pathways. HREC No.: ETH204589 being conducted by Colin Klupiec, PhD candidate, UTS School of International Studies and Education.

I have read the "Information for Student Participants and their Parents/Carers" sheet, or someone has read it to me in a language that I understand.

My parent/carer has also read the "Information for Student Participants and their Parents/Carers" sheet.

I understand the purposes, procedures and risks of the research as described in the Participant Information Sheet.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time without affecting my relationship with the researchers or the University of Technology Sydney.

I understand that I will be given a signed copy of this document to keep.

I agree to:

☐ produce 'concept map' drawings

☐ be audio recorded

I agree that the research data gathered from this project may be published in a form that:

☐ Does not identify me in any way

I am aware that I can contact Colin Klupiec if I have any concerns about the research.

_____	_____	____/____/____
Name, Signature [participant]	Student School Email	Date
_____	_____	____/____/____
Name, Signature [researcher]	UTS Email	Date
_____	_____	____/____/____
Name, Signature [witness* - parent or carer]	Email	Date

*** Witness to the consent process**
If the participant, or if their legally acceptable representative, is not able to read this document, this form must be witnessed by an independent person over the age of 18. In the event that an interpreter is used, the interpreter may not act as a witness to the consent process. By signing the consent form, the witness attests that the information in the consent form and any other written information was accurately explained to, and apparently understood by, the participant (or representative) and that informed consent was freely given by the participant (or representative).

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CONSENT FORM - Teachers

Languages and STEM: the relationship between conceptualisation, motivation and value proposition in designing secondary school learning pathways
HREC No.: ETH204589

I _____ *[participant's name]* agree to participate in the research Languages and STEM: the relationship between conceptualisation, motivation and value proposition in designing secondary school learning pathways. HREC No.: ETH204589 being conducted by Colin Klupiec, PhD candidate, UTS School of International Studies and Education.

I have read the Participant Information Sheet for Teachers, or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research as described in the Participant Information Sheet.

I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time without affecting my relationship with the researchers or the University of Technology Sydney.

I understand that I will be given a signed copy of this document to keep.

I agree to:

☐ produce 'concept map' drawings

☐ be audio recorded

I agree that the research data gathered from this project may be published in a form that:

☐ Does not identify me in any way

I am aware that I can contact Colin Klupiec if I have any concerns about the research.

_____	_____	____/____/____
Name and Signature [participant]	School email	Date
_____	_____	____/____/____
Name and Signature [researcher or delegate]	UTS email	Date
_____	_____	____/____/____
Name and Signature [witness*]	Email	Date

*** Witness to the consent process**
If the participant, or if their legally acceptable representative, is not able to read this document, this form must be witnessed by an independent person over the age of 18. In the event that an interpreter is used, the interpreter may not act as a witness to the consent process. By signing the consent form, the witness attests that the information in the consent form and any other written information was accurately explained to, and apparently understood by, the participant (or representative) and that informed consent was freely given by the participant (or representative).

Appendix D – Participant Information Sheets

Configured for each site, Schools A, B, and C due to scheduling constraints at each school.

SCHOOL A

UTS UNIVERSITY OF TECHNOLOGY SYDNEY

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Information for Student Participants and their Parents / Carers

Languages and STEM: the relationship between conceptualisation, motivation and value proposition in designing secondary school learning pathways
HREC No.: ETH204589

WHO IS DOING THE RESEARCH?
My name is Colin Klupiec and I am a student at UTS. My supervisor is Professor Lesley Harbon, on whose letterhead this information sheet is written.

WHAT IS THIS RESEARCH ABOUT?
This research is to find out about how students conceptualise the subjects of STEM and languages, and how students create a sense of value around the subjects they study.

This research does not contribute to your school assessment in any way.

FUNDING
No funding has been sought for this research.

WHY HAVE I BEEN ASKED?
You have been invited to participate in this study because you are a student in a year 9 or 10 STEM or languages class.

IF I SAY YES, WHAT WILL IT INVOLVE?
If you decide to participate, I will invite you to participate in the following activities.

Concept Map Creation

- You will be asked to draw a 'map' that describes your perception of STEM (or languages). You will be able to use lines, shapes, arrows, words, short phrases etc. This task will take a maximum of 30min, and most likely take place during a double lesson to allow for a further explanation of the task and time to ask any questions.
- This will be an individual task and will take place in a group of 5 students from your class who choose to participate.

Follow-up Audio Interview

- You will participate in a group interview with the same 5 students that produced the concept map. This will allow you to further express any thoughts or ideas on your perception of STEM that you were not able to draw. You may also choose this time to clarify aspects of the map you have created. The group interview will be guided by me, the researcher.
- The interview will take approximately 30min and will take place during a double lesson to allow for any questions prior to commencing the interview.
- This interview will be recorded for the purposes of creating a written transcript.

You will need your parents' or caregivers' permission to participate in this research.

How much school time will this take up? Students will be needed for one session of Sport in Week 3 and for one Morning Prayer Session in Week 4.

ARE THERE ANY RISKS/INCONVENIENCE?
Yes, there are some risks/inconvenience. They are:

- You may feel uncomfortable about participating in a university research study, or what your fellow students may say about your decision to participate.
- You may feel embarrassed about the drawings you produce. Whilst using drawings is a normal part of producing design solutions in STEM (but perhaps not so much in languages), you may feel less comfortable about representing your personal perceptions as drawings.
- You may feel self-conscious about being recorded in a group discussion.

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PARTICIPANT INFORMATION SHEET - Teachers

Languages and STEM: the relationship between conceptualisation, motivation and value proposition in designing secondary school learning pathways
HREC No.: ETH204589

WHO IS DOING THE RESEARCH?

My name is Colin Klupiec and I am a student at UTS. My supervisor is Professor Lesley Harbon, on whose letterhead this information sheet is written.

WHAT IS THIS RESEARCH ABOUT?

This research is to find out about how students conceptualise the subjects of STEM and languages, and how students create a sense of value around the subjects they study.

FUNDING

No funding has been sought for this research.

WHY HAVE I BEEN ASKED?

You have been invited to participate in this study because you are a teacher of a year 9 or 10 STEM or languages class.

IF I SAY YES, WHAT WILL IT INVOLVE?

If you decide to participate, I will invite you to participate in the following activities.

Concept Map Creation

- You will be asked to draw a 'map' that describes your perception of STEM (or languages). You will be able to use lines, shapes, arrows, words, short phrases etc. This task will take a maximum of 30min, and most likely take place during a double lesson to allow for a further explanation of the task and time to ask any questions.
- This will be an individual task and will take place with a group of 5 students from your class who choose to participate.

Follow-up Audio Interview

- You will participate in an interview with me. This will allow you to further express any thoughts or ideas on your perception of STEM (or languages) that you were not able to draw. You may also choose this time to clarify aspects of the map you have created.
- The interview will take approximately 30min and will take place at a time convenient for you.
- This interview will be recorded for the purposes of creating a written transcript.

How much school time will this take up? Students will be needed for one session of Sport in Week 3 and for one Morning Prayer Session in Week 4.

ARE THERE ANY RISKS/INCONVENIENCE?

Yes, there are some risks/inconvenience. They are:

- You may feel uncomfortable about participating in a university research study, or what your colleagues may say about your decision to participate.
- You may feel embarrassed about the drawings you produce.
- You may feel self-conscious about being recorded in an interview.

WHAT HAPPENS IF I FEEL UNCOMFORTABLE OR SELF-CONSCIOUS?

If you start to feel uncomfortable or self-conscious in any way during concept map drawing or recorded interview, you may

- Withdraw from the research without having to give a reason and return to normal lessons

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WHAT IS THIS RESEARCH ABOUT?

This research is to find out about how students conceptualise the subjects of STEM / Design and Technology and languages, and how students create a sense of value around the subjects they study.

This research does not contribute to your school assessment in any way.

FUNDING

No funding has been sought for this research.

WHY HAVE I BEEN ASKED?

You have been invited to participate in this study because you are a student in a year 9 or 10 STEM / Design and Technology or languages class.

IF I SAY YES, WHAT WILL IT INVOLVE?

If you decide to participate, I will invite you to participate in the following activities.

Concept Map Creation

- You will be asked to draw a 'map' that describes your perception of STEM / Design and Technology (or languages). You will be able to use lines, shapes, arrows, words, short phrases etc. This task will take a maximum of 30min, and most likely take place during a double lesson to allow for a further explanation of the task and time to ask any questions.
- This will be an individual task and will take place in a group of 5 students from your class who choose to participate.

Follow-up Audio Interview

- You will participate in a group interview with the same 5 students that produced the concept map. This will allow you to further express any thoughts or ideas on your perception of STEM / Design and Technology / languages that you were not able to draw. You may also choose this time to clarify aspects of the map you have created. The group interview will be guided by me, the researcher.
- The interview will take approximately 30min and may take place during a double lesson to allow for any questions prior to commencing the interview.
- This interview will be recorded for the purposes of creating a written transcript.

Approximately 1 term later, this process will be repeated where you will be presented with anonymised findings from the other subject (either STEM / Design and Technology or languages) as a stimulus for your response.

You will need your parents' or caregivers' permission to participate in this research.

ARE THERE ANY RISKS/INCONVENIENCE?

Yes, there are some risks/inconvenience. They are:

- You may feel uncomfortable about participating in a university research study, or what your fellow students may say about your decision to participate.
- You may feel embarrassed about the drawings you produce. Whilst using drawings is a normal part of producing design solutions in STEM / Design and Technology (but perhaps not so much in languages), you may feel less comfortable about representing your personal perceptions as drawings.
- You may feel self-conscious about being recorded in a group discussion.

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PARTICIPANT INFORMATION SHEET - Teachers

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WHO IS DOING THE RESEARCH?

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WHAT IS THIS RESEARCH ABOUT?

This research is to find out about how students conceptualise the subjects of STEM / Design and Technology and languages, and how students create a sense of value around the subjects they study.

FUNDING

No funding has been sought for this research.

WHY HAVE I BEEN ASKED?

You have been invited to participate in this study because you are a teacher of a year 9 or 10 STEM / Design and Technology, or languages class.

IF I SAY YES, WHAT WILL IT INVOLVE?

If you decide to participate, I will invite you to participate in the following activities.

Concept Map Creation

- You will be asked to draw a 'map' that describes your perception of STEM / Design and Technology (or languages). You will be able to use lines, shapes, arrows, words, short phrases etc. This task will take a maximum of 30min, and most likely take place during a double lesson to allow for a further explanation of the task and time to ask any questions.
- This will be an individual task and will take place with a group of 5 students from your class who choose to participate.

Follow-up Audio Interview

- You will participate in an interview with me. This will allow you to further express any thoughts or ideas on your perception of STEM / Design and Technology (or languages) that you were not able to draw. You may also choose this time to clarify aspects of the map you have created.
- The interview will take approximately 30min and will take place at a time convenient for you.
- This interview will be recorded for the purposes of creating a written transcript.

Approximately 1 term later, this process will be repeated where you will be presented with anonymised findings from the other subject (either STEM / Design and Technology or languages) as a stimulus for your response.

ARE THERE ANY RISKS/INCONVENIENCE?

Yes, there are some risks/inconvenience. They are:

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If you start to feel uncomfortable or self-conscious in any way during concept map drawing or recorded interview, you may

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If you decide to participate, I will invite you to participate in the following activities.

Concept Map Creation

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- This will be an individual task and will take place in a group of students from your class who choose to participate.

Follow-up Audio Interview

- You will participate in a group interview with the same students that produced the concept map. This will allow you to further express any thoughts or ideas on your perception of STEM / Design and Technology / languages that you were not able to draw. You may also choose this time to clarify aspects of the map you have created. The group interview will be guided by me, the researcher.
- The interview will take approximately 10-15min and will take place immediately after the concept map drawing exercise.
- This interview will be recorded for the purposes of creating a written transcript.

Several weeks later, this process will be repeated where you will be presented with anonymised findings from the other subject (either STEM / Design and Technology or languages) as a stimulus for your response.

You will need your parents' or caregivers' permission to participate in this research.

ARE THERE ANY RISKS/INCONVENIENCE?

Yes, there are some risks/inconvenience. They are:

- You may feel uncomfortable about participating in a university research study, or what your fellow students may say about your decision to participate.
- You may feel embarrassed about the drawings you produce. Whilst using drawings is a normal part of producing design solutions in STEM / Design and Technology (but perhaps not so much in languages), you may feel less comfortable about representing your personal perceptions as drawings.
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PARTICIPANT INFORMATION SHEET - Teachers

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Concept Map Creation

- You will be asked to draw a 'map' that describes your perception of STEM / Design and Technology (or languages). You will be able to use lines, shapes, arrows, words, short phrases etc. This task will take a maximum of 30min. You will have time to ask questions before you commence.
- This will be an individual task and will take place with a group of students from your class who choose to participate.

Follow-up Audio Interview

- You will participate in an interview with me or together with the students. This will allow you to further express any thoughts or ideas on your perception of STEM / Design and Technology (or languages) that you were not able to draw. You may also choose this time to clarify aspects of the map you have created.
- The interview will take approximately 10-15min.
- This interview will be recorded for the purposes of creating a written transcript.

Several weeks later, this process will be repeated where you will be presented with anonymised findings from the other subject (either STEM / Design and Technology or languages) as a stimulus for your response.

ARE THERE ANY RISKS/INCONVENIENCE?

Yes, there are some risks/inconvenience. They are:

- You may feel uncomfortable about participating in a university research study, or what your colleagues may say about your decision to participate.
- You may feel embarrassed about the drawings you produce.
- You may feel self-conscious about being recorded in an interview.

WHAT HAPPENS IF I FEEL UNCOMFORTABLE OR SELF-CONSCIOUS?

If you start to feel uncomfortable or self-conscious in any way during concept map drawing or recorded interview, you may

- Withdraw from the research without having to give a reason and return to normal lessons

Appendix E – Concept Map Samples and Instructions

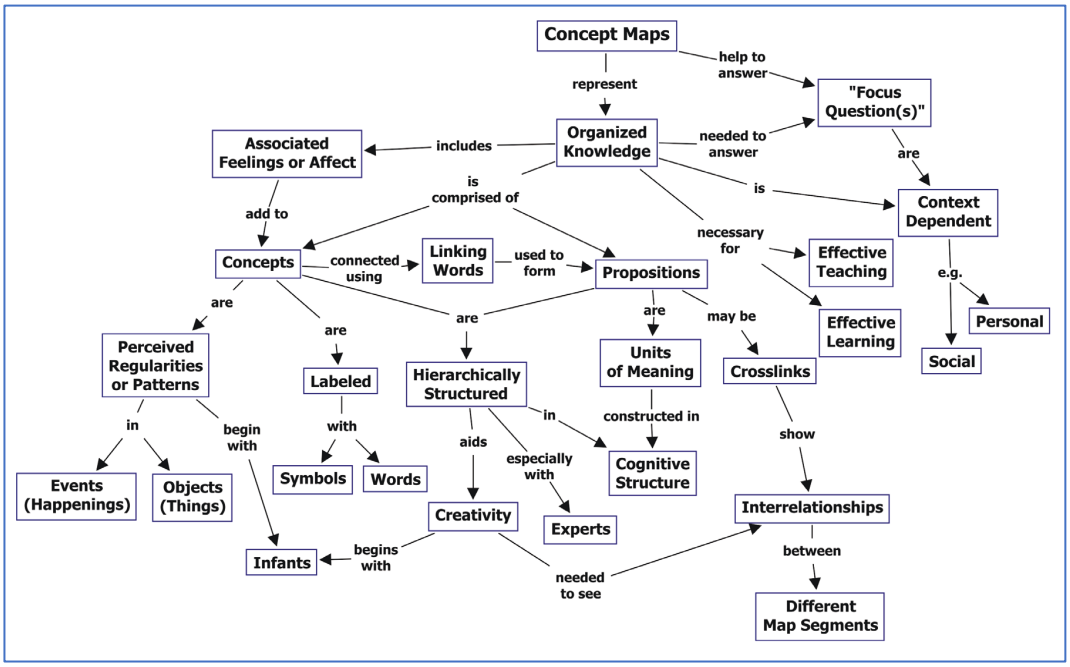


Figure 62 Novak, J. and A. Cañas (2008).

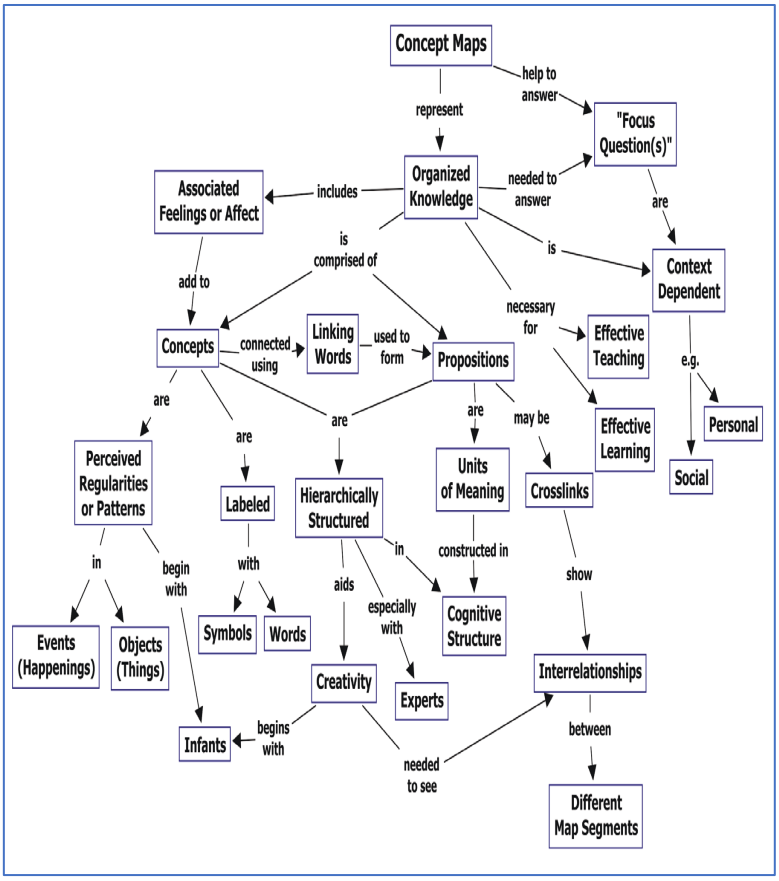


Figure 63 Novak, J. D. (1995).

Concept Maps - Participant Instructions

On the attached sheet, create a 'map' that describes your perception of STEM / Technology / Languages education. You may use:

- words
- lines, arrows etc. (to join **concepts**, ideas, thought processes)
- sketches
- short phrases

Focus Questions

How do you conceptualise STEM / Technology Education / Languages?

What factors influenced your sense of value in making this subject selection?

Consider…

- concepts within the course, or your perception of the course
- how they connect and relate to one another
- which are more or less important
- what is valuable to you, and why

To help you get started, you might like to visualize:

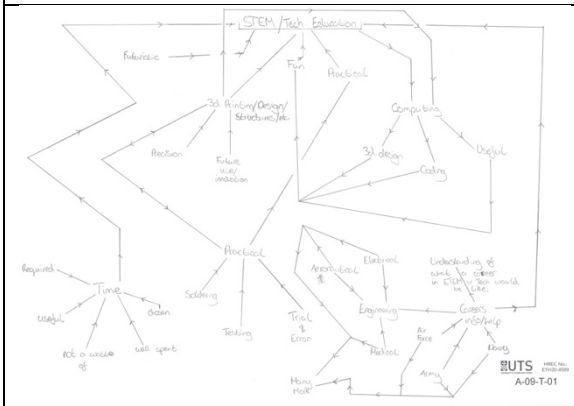
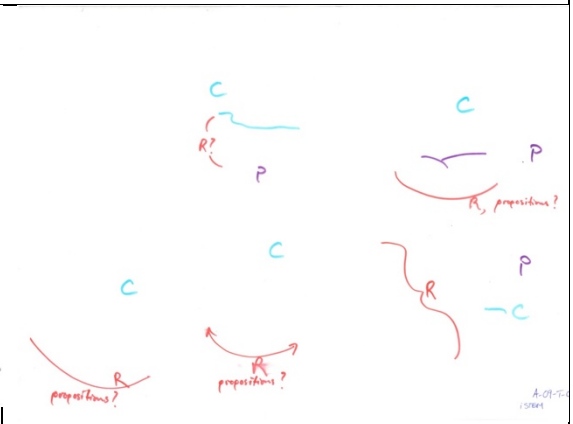
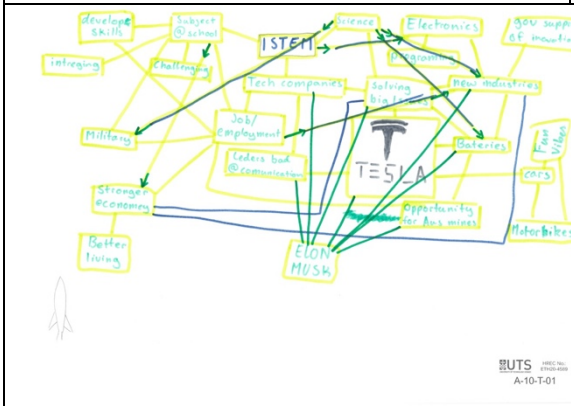
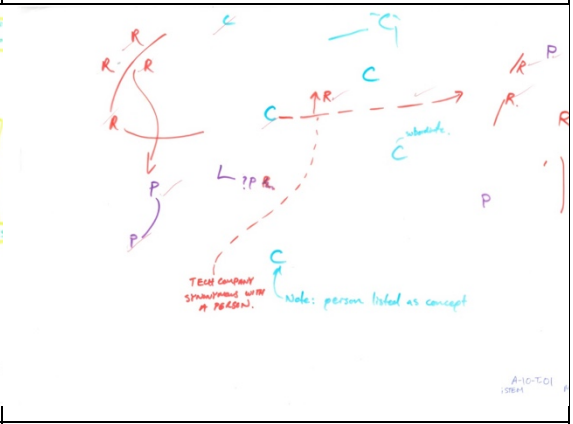
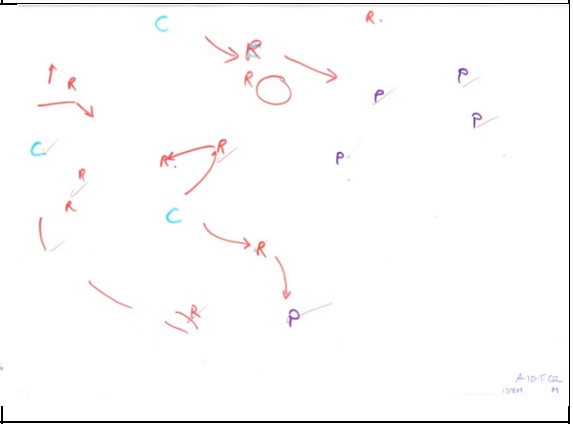
- what you thought the subject would be like prior to starting the course;
- what content and topics you thought it might cover prior to starting the course;
- how you thought the content might be structured: topics, themes etc?;
- what impact you think the subject might have for you, locally, the world;
- where you think the subject might draw its influences from;
- what the subject might inspire you to do.

The above are suggestions. You might like to represent your concept map with different ideas.

Complete your concept map on one A3 page supplied.
Do not put your name on the page.

Appendix F – School A, Phase 1 & 2 Concept Maps, Overlays, Data Reduction Tables

Table 65 School A Phase 1 Concept Maps and Analysis Overlays

School A – Phase 1 Concept Maps and Analysis Overlays	
	
A-09-T-01	A-09-T-01 overlay
	
A10-T-01	A10-T-01 overlay
	
A-T10-T-02	A-10-T-02 overlay

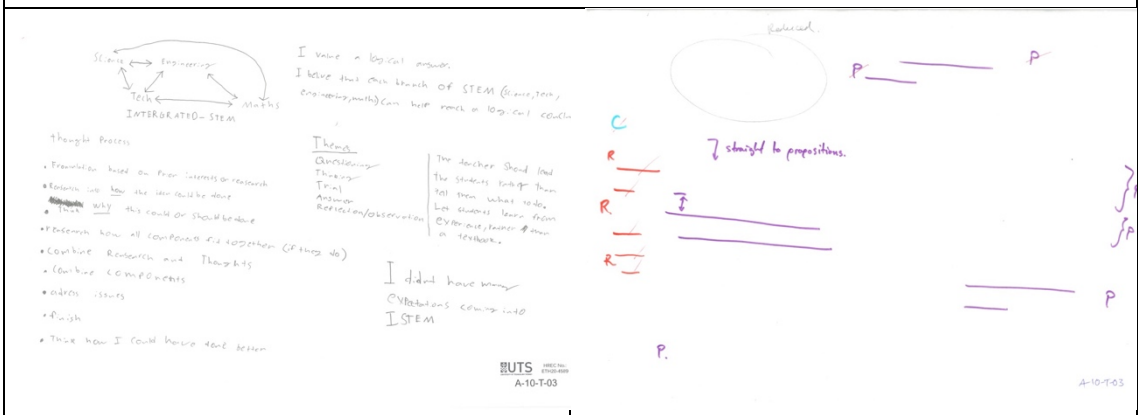
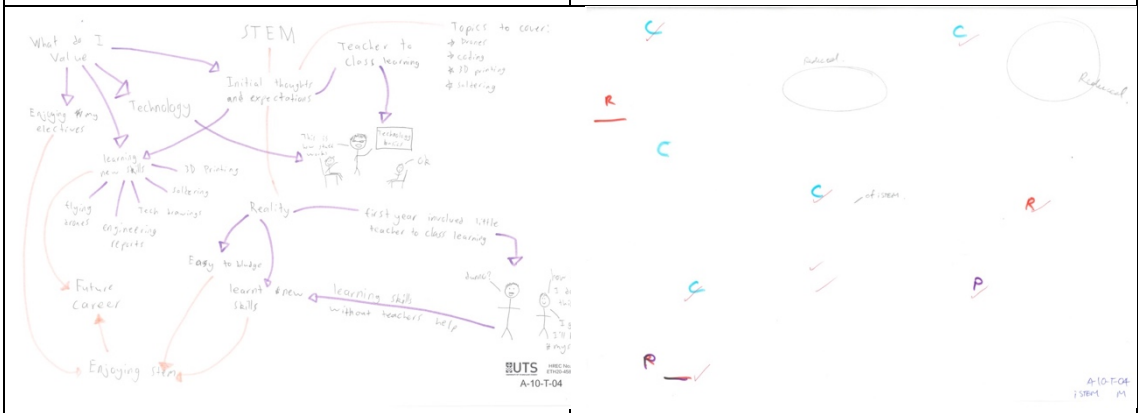
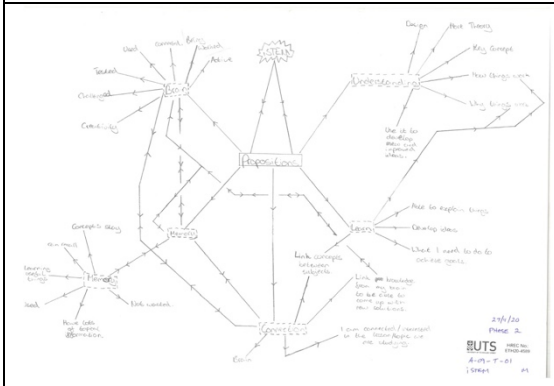
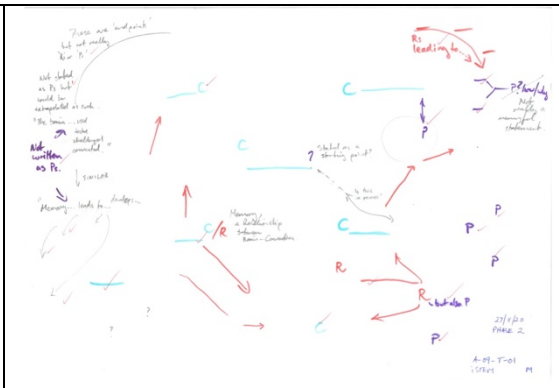
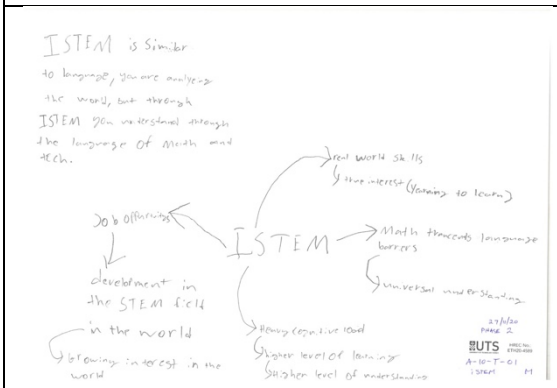
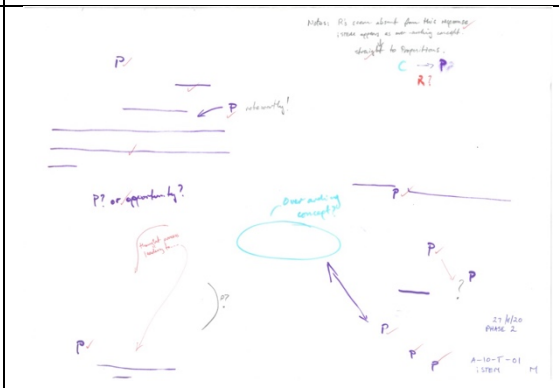
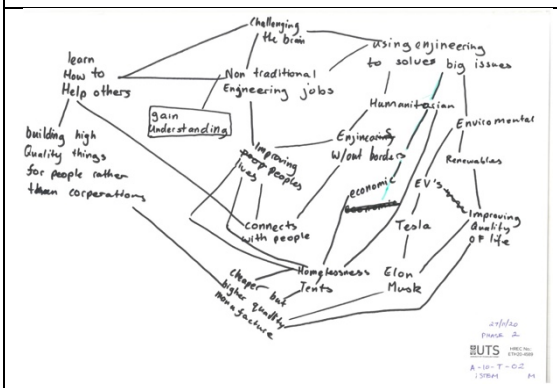
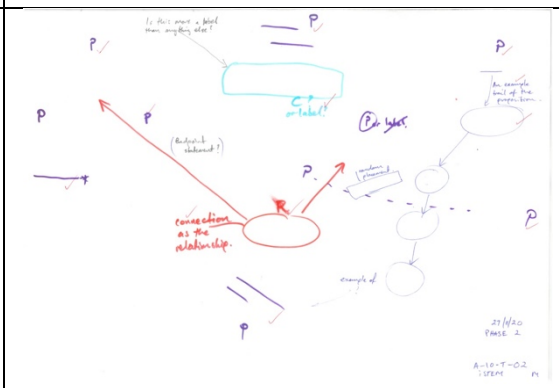
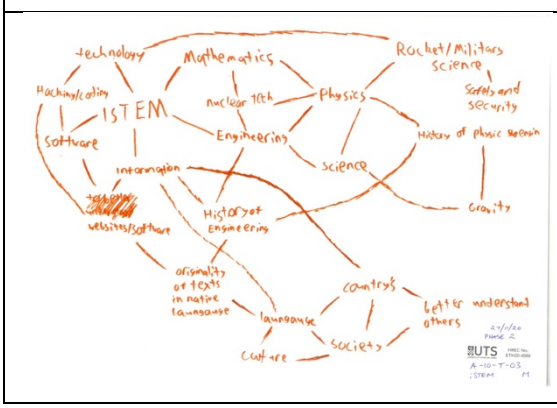
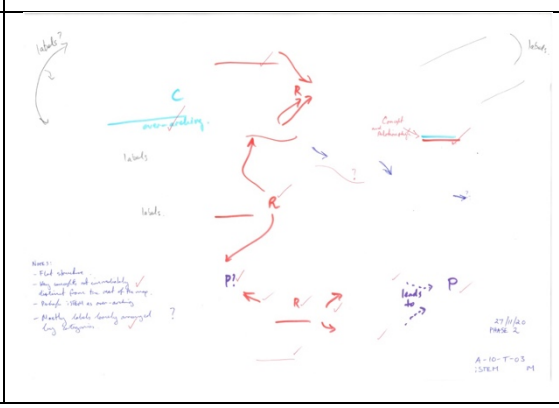
School A – <u>Phase 1</u> Concept Maps and Analysis Overlays	
	
A-10-T-03	A-10-T-03 overlay
	
A-10-T-04	A-10-T-04 overlay

Table 66 School A - Phase 1 Concept Map Data Reduction Table

School A – Phase 1 Concept Map Data Reduction Table							
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**	**Notes**
A-10-T-03	T	iSTEM	M	thought process	formulation		
					research	why or how this could be done	
						how all the components fit together (if they do)	
					combine	research and thoughts	
						I value a logical answer	propositions with no concepts or relationships mapped
						I believe that each branch of STEM can help with a logical conclusion	
						the teacher should lead the students rather than tell them what to do	
						let students learn from examples rather than a textbook	
A-10-T-04	T	iSTEM	M	teacher to class learning		(reinforced with stick figure drawings)	
				what I value	enjoying my electives	enjoying STEM	
					technology		
				learning new skills	3D printing		
					soldering		
					tech drawings		
					engineering reports		
					flying drones		
				reality (of class experience)	easy to bludge		as opposed to initial thoughts and expectations
					learnt skills		
					first year, little teacher to class learning	learning skills without teacher help	
				future career			
A-10-T-01	T	iSTEM	M	subject at school	develop skills		
					integrating	better living	
					challenging	stronger economy	
				job/employment	military		
					tech companies	opportunities for Australian miners	
				solving big issues	new industries	government suppression of innovation	
				Elon Musk		leaders bad at communication	person listed as a concept
				Tesla	solving big issues		Company shown as graphic
					cars		
					fun vibes		
					motorbikes		
				iSTEM			
				science			
				electronics			
				programming			
A-09-T-01	T	iSTEM	M	3D printing/design/structures	precision	future use, innovation	
				computing	3D design	useful	
					coding		
				practical	soldering		
					testing		
					trial & error		
				time	chosen	well spent	time spent in iSTEM?
					required	not a waste of	
				careers	electrical	understanding of what a career in STEM or Tech would be like	note the distinction, STEM OR Tech
					aeronautical		
					engineering		
					medical		
					Army, navy, air force		
A-10-T-02	T	iSTEM	M	skill development	life roles open	real life application	
					learn to create	stronger economy	
						meet new people	

School A – Phase 1 Concept Map Data Reduction Table							
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**	**Notes**
						new ways to learn	
				military hardware	civilian use tech		
					life (medicine)		
					BAE		use of company name
					army, navy, air force	reason I joined	
				innovation	military		heavily supported with sketches including rockets, satellites, wifi symbol, computer (online learning)
					rocket science		
					satellite communication		
					internet		
					online learning		
					creativity		
					Engineering		

Table 67 School A Phase 2 Concept Maps and Analysis Overlays

School A – <u>Phase 2</u> Concept Maps and Analysis Overlays	
	
A-09-T-01	A-09-T-01 overlay
	
A10-T-01	A-10-T-01 overlay
	
A-10-T-02	A-10-T-02 overlay
	

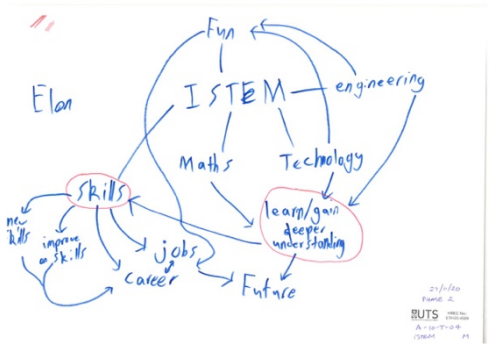
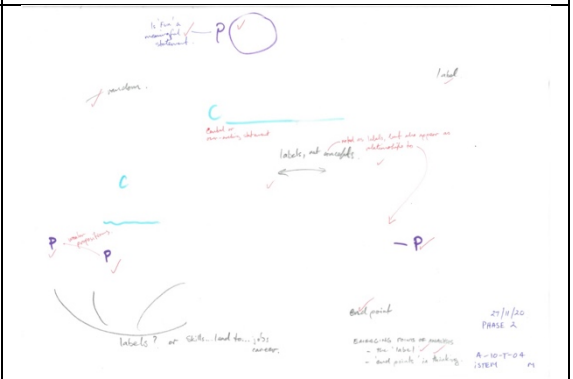
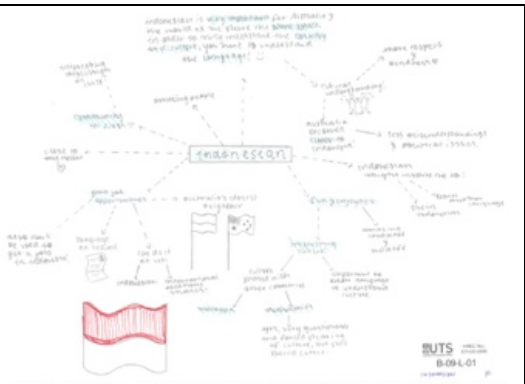
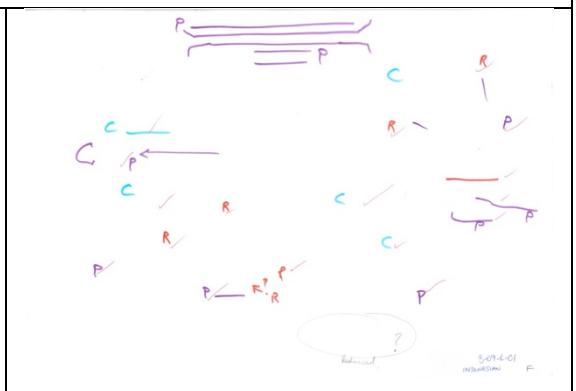
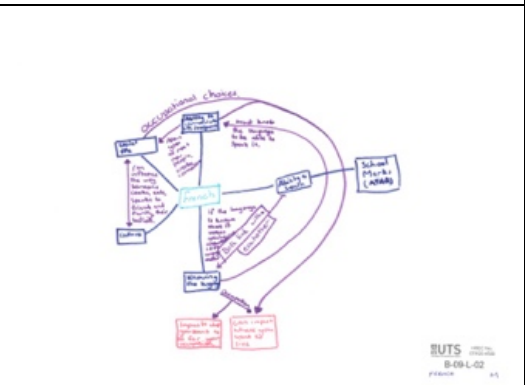
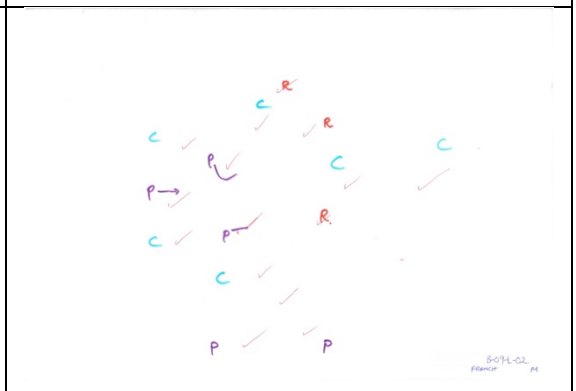
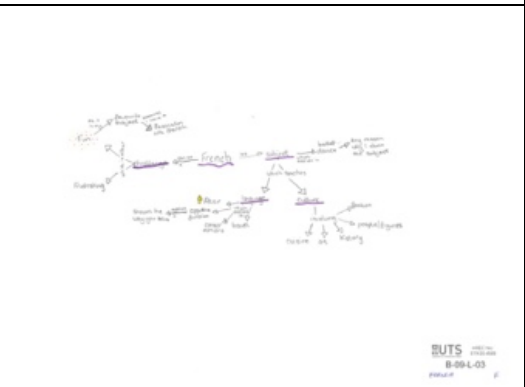
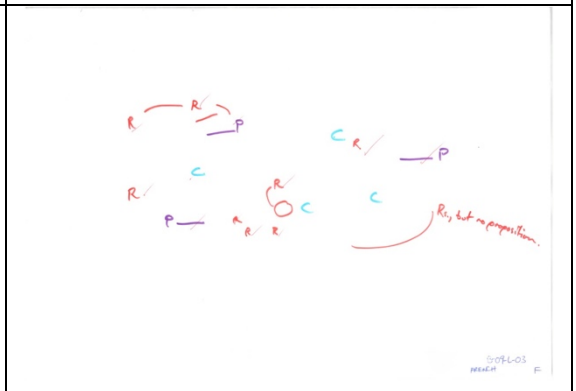
School A – <u>Phase 2</u> Concept Maps and Analysis Overlays	
A-10-T-03	A-10-T-03 overlay
	
A-10-T-04	A-10-T-04 overlay

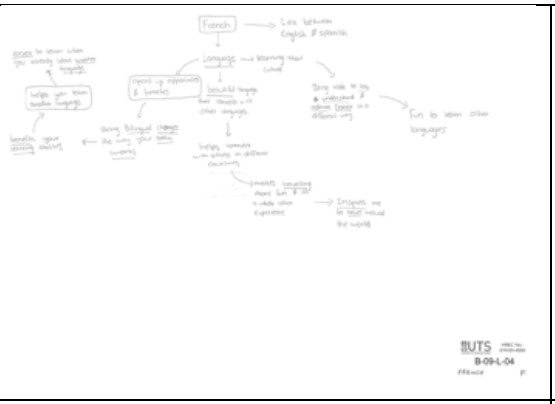
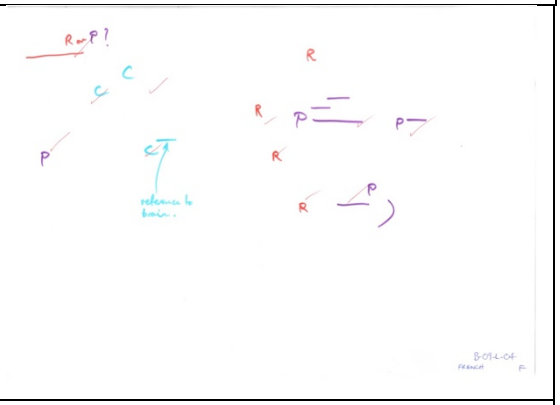
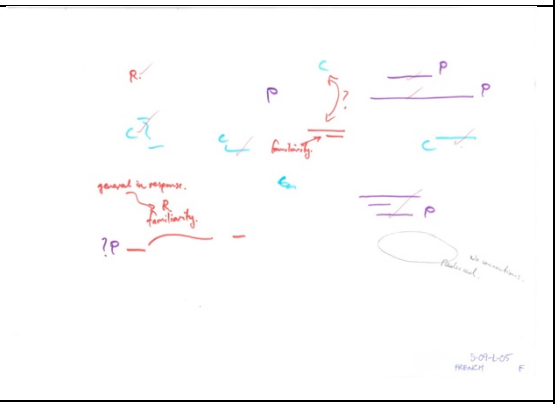
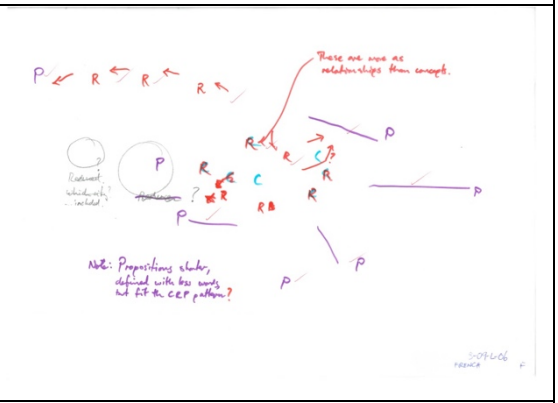
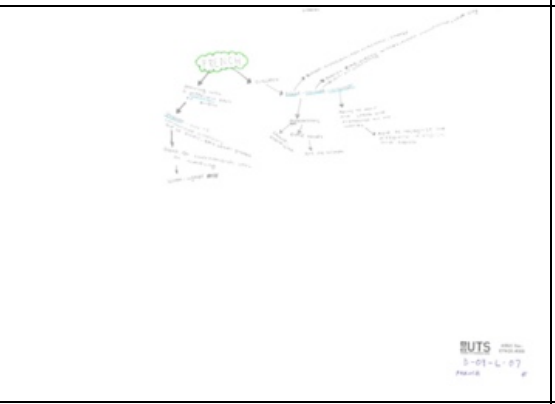
Table 68 School A - Phase 2 Concept Map Data Reduction Table

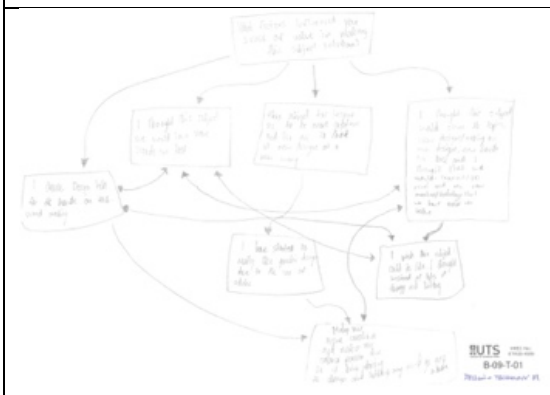
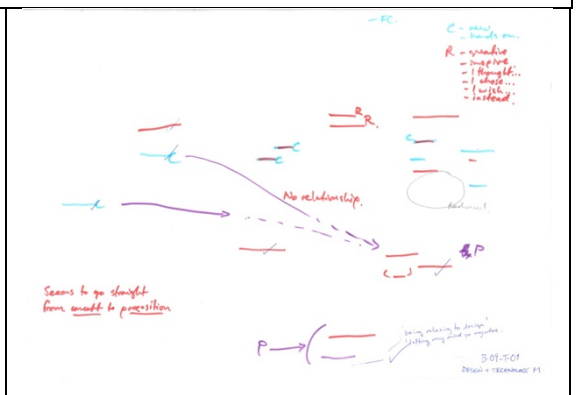
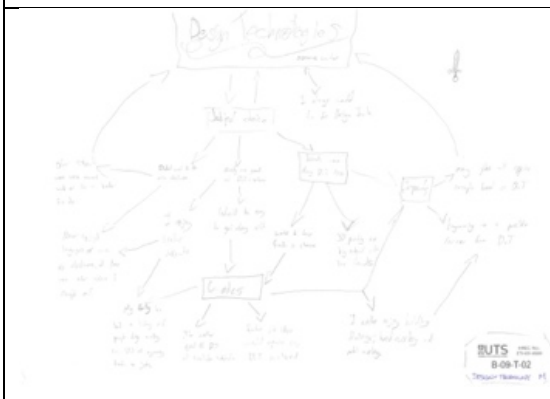
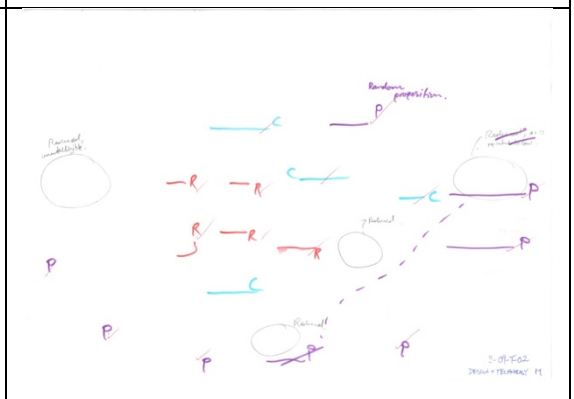
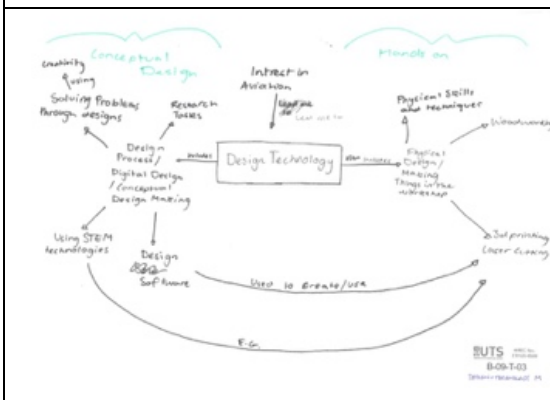
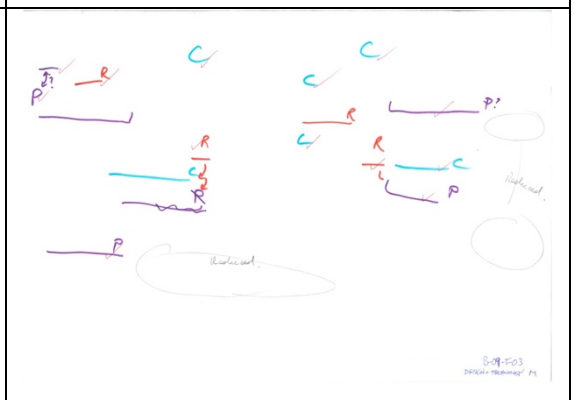
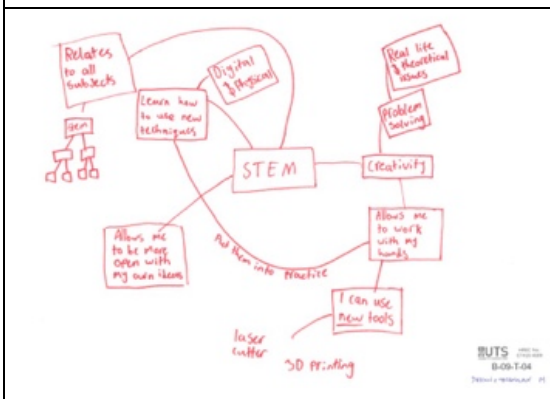
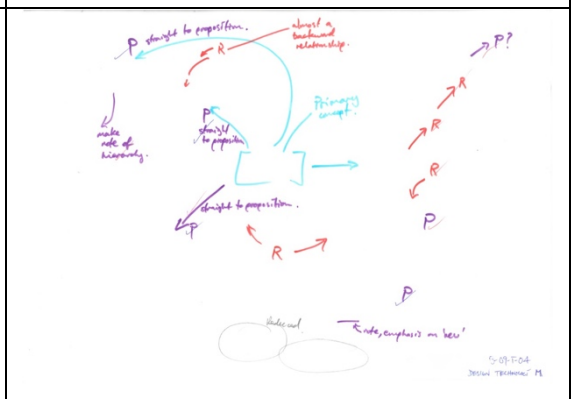
School A – Phase 2 Concept Map Data Reduction Table							
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**	**Notes**
A-09-T-01	T	iSTEM	M	Brain		Active	
					linked by arrows to those shown right..	being worked, challenged	
						connected	Those shown left were written as labels, not connected
						Used, tested	in meaning statements.
						creativity	
				Memory	concepts stay		
				c	can recall		
					learning useful things		
					have lots of topical information		
					not wasted		
				Connection		I am connected/interested in the lesson/topic we are studying	
				memory also shown between		what I need to do to achieve goals	
				brain' and 'connection'			
				Propositions			shown as a central concept
				understanding	design	use it to develop new and improved ideas	
					more theory	how and why things work	
					key concepts	develop ideas	
				learn	links concepts between subjects	able to explain things	
					link knowledge	link knowledge from my brain to be able to come up with new solutions	
A-10-T-01	T	iSTEM	M	iSTEM		is similar to language, you are analysing the world	iSTEM appears to be the over-arching concept
						but through iSTEM you understand through the language of math and tech	relationships seem absent in this response
						growing interest in the world	straight from Concept to Proposition
						real world skills	
						learning to learn	
						maths transcends language barriers	
						universal understanding	
						heavy cognitive load	
						higher level of learning	
						higher level of understanding	
						job opportunities	
A-10-T-02	T	iSTEM	M	non-traditional engineering jobs		challenging the brain	Concept or label? Appears central.
						using engineeering to solve big issues	
						gain understanding	
					connects with people	learn how to help others	
						engineering without borders	
					Environment, EVs, Tesla, Elon Musk	improving quality of life	
						cheaper but higher quality manufacture	
						building high quality things for people rather than corporations	
A-10-T-03	T	iSTEM	M	iSTEM	engineering, history of	originality of texts in native language	appears to be the over-arching concept
					language		Flat structure
					culture		key concepts not immediately apparent or distinct
					society		mostly labels loosely arranged
					country's	better understanding of others	
				history	physics		
					science	history of physics and engineering	
					mathematics		
A-10-T04	T	iSTEM	M	iSTEM	maths		
					technology		Emerging points of analysis
					engineering	learn/gain deeper understanding	the 'label'
				Skills		new skills, imrove skills	end points in thinking
						future (appears as an endpoint in thinking)	
						fun (is this a proposition, or random label)	

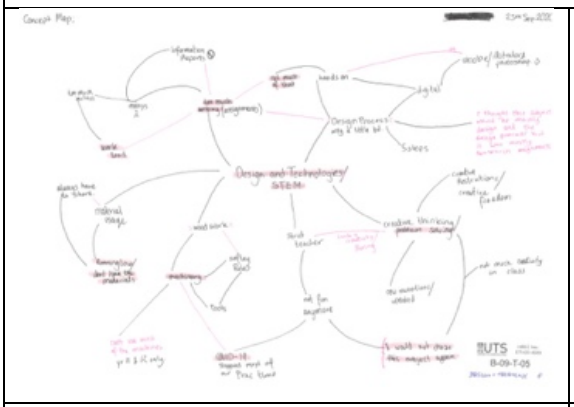
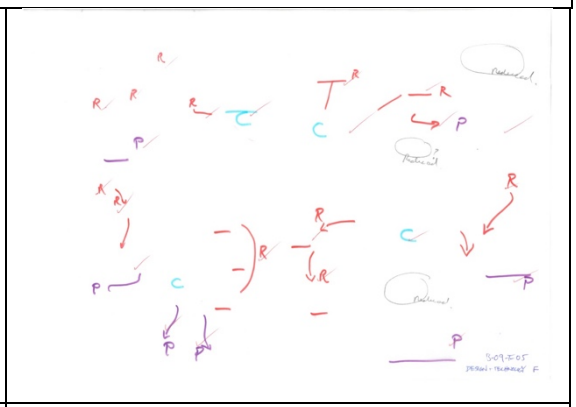
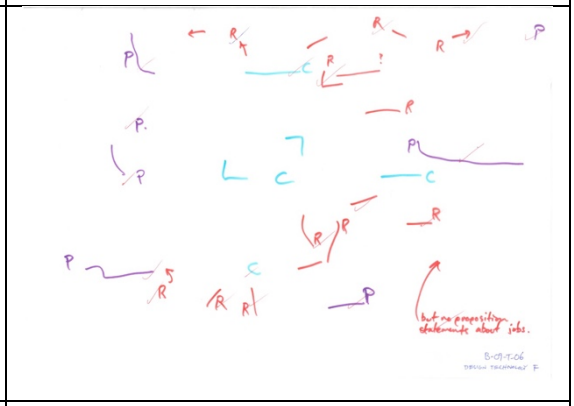
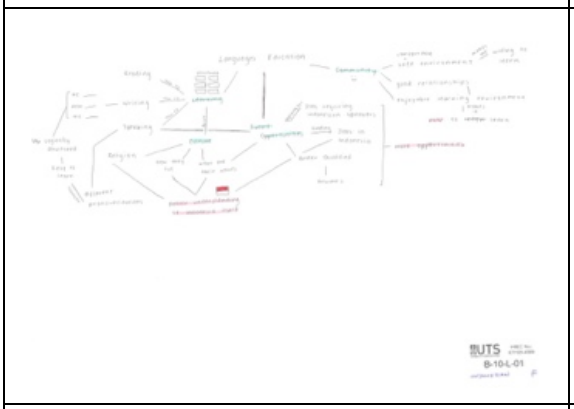
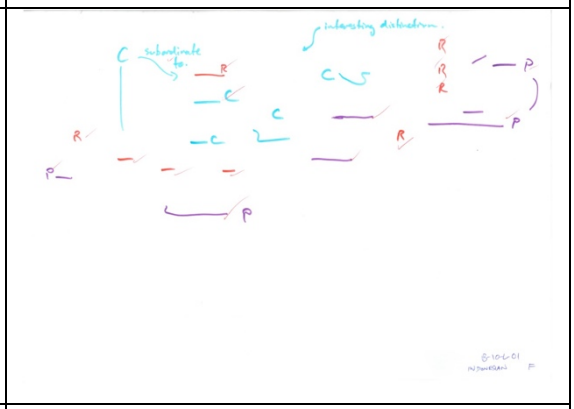
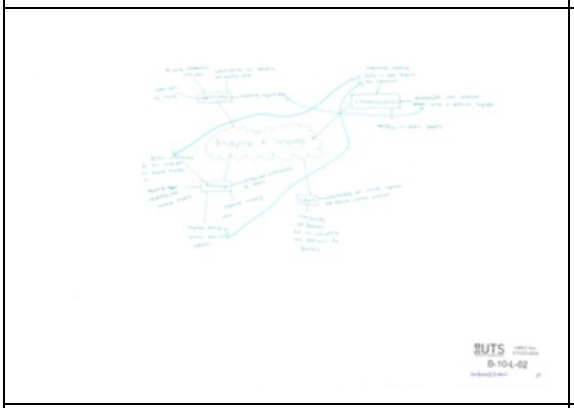
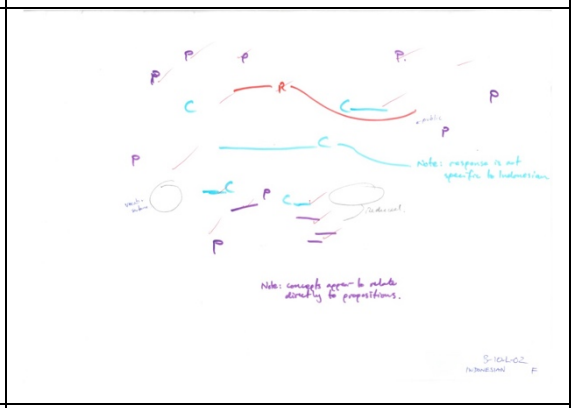
Appendix G – School B, Phase 1 & 2 Concept Maps, Overlays, Data Reduction Tables

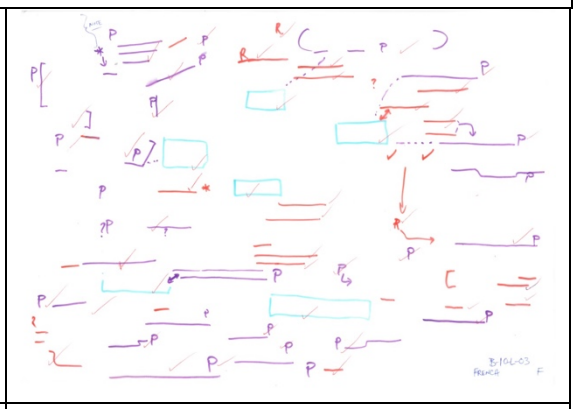
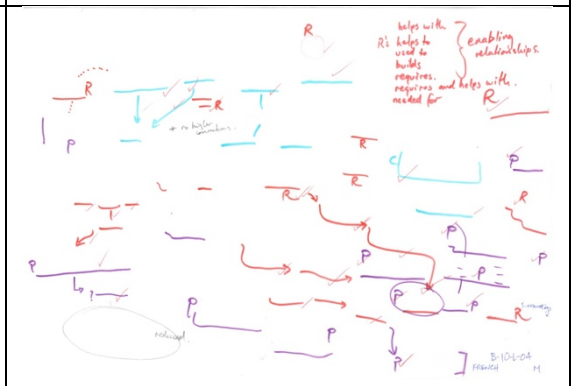
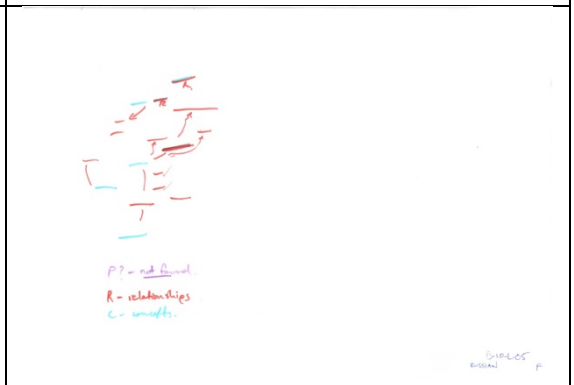
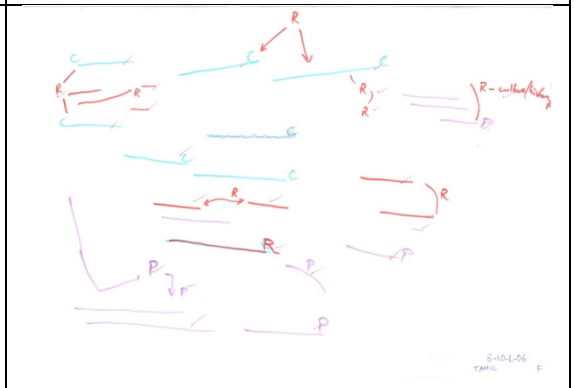
Table 69 School B - Phase 1 Concept Maps and Analysis Overlays

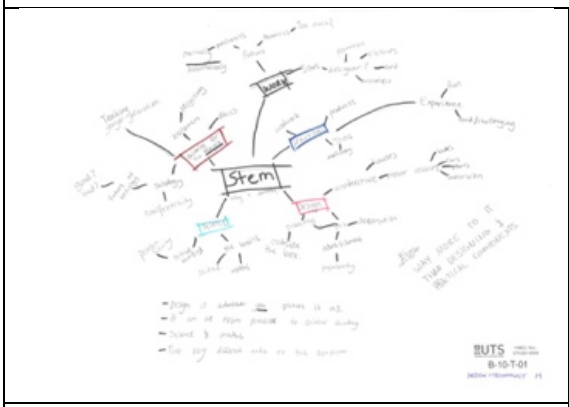
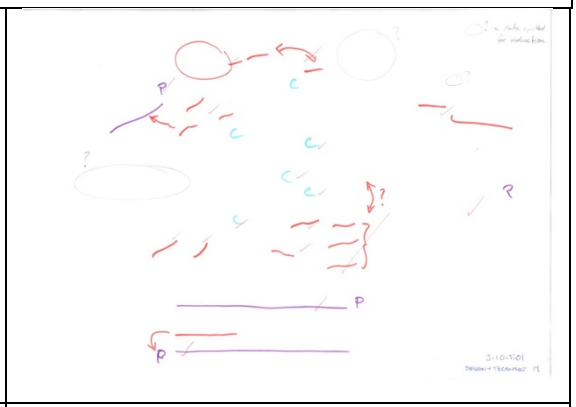
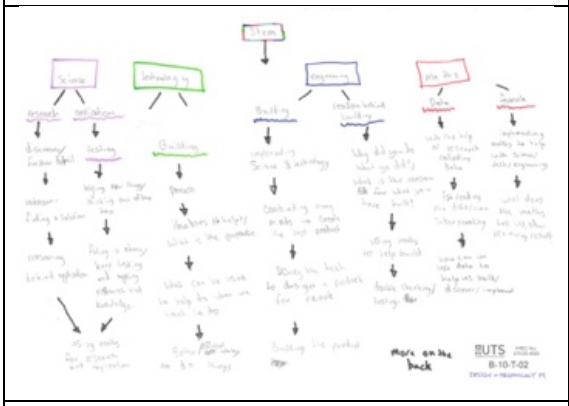
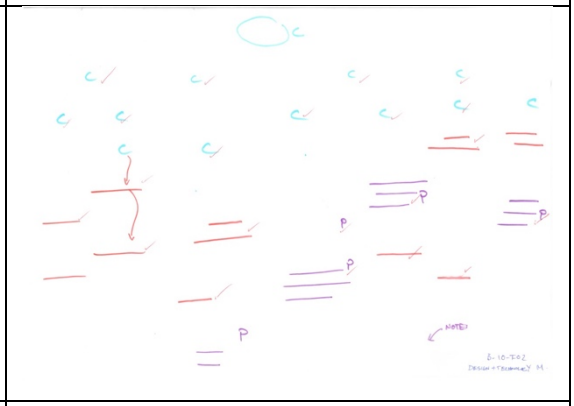
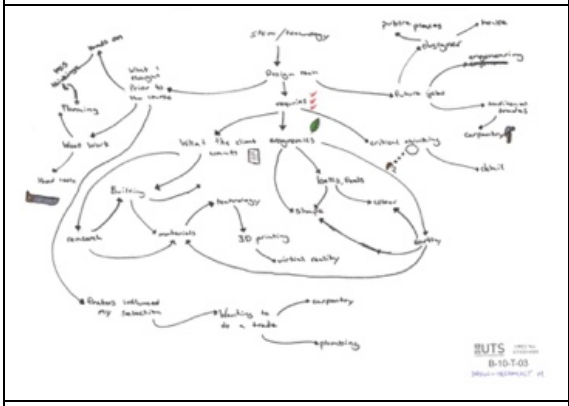
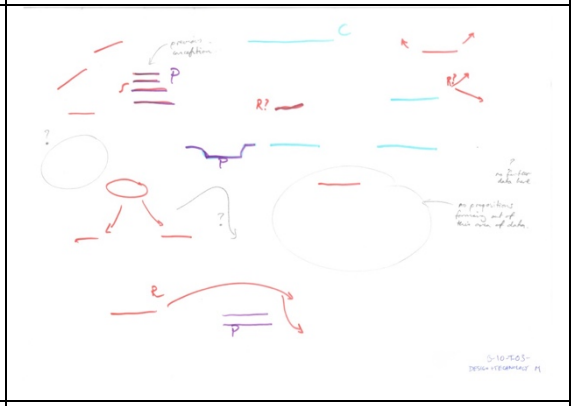
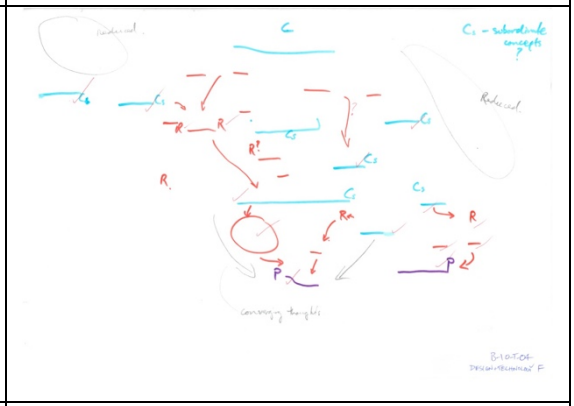
School B – <u>Phase 1</u> Concept Maps and Analysis Overlays	
	
B-09-L-01	B-09-L-01 overlay
	
B-09-L-02	B-09-L-02 overlay
	
B-09-L-03	B-09-L-03 overlay

School B – <u>Phase 1</u> Concept Maps and Analysis Overlays	
	
B-09-L-04	B-09-L-04 overlay
	
B-09-L-05	B-09-L-05 overlay
	
B-09-L-06	B-09-L-06 overlay
	
B-09-L-07	B-09-L-07 overlay

School B – <u>Phase 1</u> Concept Maps and Analysis Overlays	
	
B-09-T-01	B-09-T-01 overlay
	
B-09-T-02	B-09-T-02 overlay
	
B-09-T-03	B-09-T-03 overlay
	
B-09-T-04	B-09-T-04 overlay

School B – <u>Phase 1</u> Concept Maps and Analysis Overlays	
	
B-09-T-05	B-09-T-05 overlay
	
B-09-T-06	B-09-T-06 overlay
	
B-10-L-01	B-10-L-01 overlay
	
B-10-L-02	B-10-L-02 overlay

School B – <u>Phase 1</u> Concept Maps and Analysis Overlays	
	
B-10-L-03	B-10-L-03 overlay
	
B-10-L-04	B-10-L-04 overlay
	
B-10-L-05	B-10-L-05 overlay
	
B-10-L-06	B-10-L-06 overlay

School B – <u>Phase 1</u> Concept Maps and Analysis Overlays	
	
B-10-T-01	B-10-T-01 overlay
	
B-10-T-02	B-10-T-02 overlay
	
B-10-T-03	B-10-T-03 overlay
	
B-10-T-04	B-10-T-04 overlay

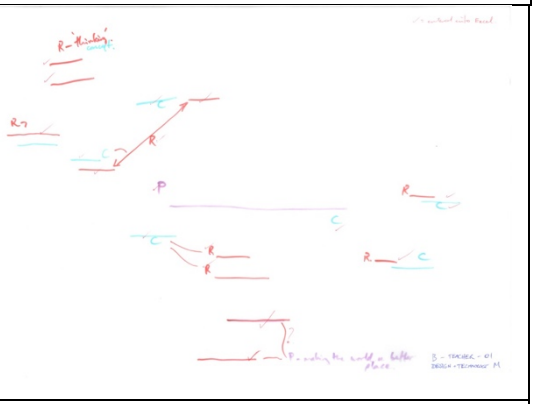
School B – <u>Phase 1</u> Concept Maps and Analysis Overlays	
	
B-Teacher-T-01	B-Teacher-T-01 overlay

Table 70 School B – Phase 1 Concept Map Data Reduction Table – languages participants

School B – Phase 1 Concept Map Data Reduction Table – languages participants								
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**	**Notes**	**Reduced propositions**
B-09-L-01	L	Indonesian	F	job opportunities	language on resume	can be used to get a job in Indonesia		to get a job
					Australia's closest neighbour			
					can do it at uni	international relations studies		
				community in class		interesting discussion in class		
				cultural understanding	more respect and kindness			
					Aus becomes closer to Indonesia	less misunderstanding and political issues		less misunderstanding
				inspire	might	learn another language		
						live in Indonesia		
				fun, enjoyable				
				interesting culture		important to know language to understand culture		to understand
						culture shared with other countries		shared
						close to my heart	propositions with no concepts or relationships	
						Indonesian is very important for Australia because they share the same space		
						to truly understand the country and culture you have to understand the language		to truly understand
B-09-L-02	L	French	M	ability to communicate with foreigners				
				knowing the language	must know the language to speak it	allows you to meet new people, create connections		create connections
					occupation	impacts what you want to do for your occupation		occupation
						can impact where you want to live		
				ability to learn	knowing / learning	if the language is known then it makes gaining understanding of the language easier		gaining understanding
				social life	occupational choices			
				culture		can influence the way someone cooks, eats, speaks to friends and family, their beliefs		can influence
				school marks / ATAR				
B-09-L-03	L	French	F	challenge	fun / favourite	fascination with French		
					frustrating			
				french	assists in ballet, dance	key reason why I chose the subject		
				culture	fashion			

School B – Phase 1 Concept Map Data Reduction Table – languages participants								
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**	**Notes**	**Reduced propositions**
					people/figures			
					history			
					art			
					cuisine			
				language	assists in			
					travel			
					career options	shapes the way you think		shapes the way you think
					cognitive function			
B-09-L-04	L	French	F	opens up opportunities & branches				
				changes the way your brain works		benefits your learning abilities		benefits your learning abilities
						easier to learn when you already speak another language		to learn
				French				
					beautiful language			
					helps connect			
					makes travelling more fun	inspires me to travel around the world		
					culture	see, understand and admire France in a different way		understand and admire
						fun to learn other languages		
B-09-L-05	L	French	F	culture & difference	food			
					visual and performing arts			
				wanderlust				
				opportunities	enabling myself to become familiar	non materialised reward for learning about another country		non-materialised reward for learning
						beneficial to the brain, learning another language		beneficial to the brain
						to rid ignorance	no apparent concepts or relationships mapped	to rid ignorance
						opens you up to other cultures		opens you up
					familiarity			
B-09-L-06	L	French	F	French	receive	ATAR points		
					easy	to learn		to learn
					difference	between Aussie culture		
					love	the language		
					influence	sport, family, friends, food		
					beneficial	for when I go to France		
						love their flag		
						love their city		
						have family in France		
					learn	the basics of the subject, enough to talk to French people		
B-09-L-07	L	French	F	learning with a different part of	able to communicated			

School B – Phase 1 Concept Map Data Reduction Table – languages participants								
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**	**Notes**	**Reduced propositions**
				the brain	differently			
					and with others			
					get better grades			
					good for	international jobs or travelling		(international) jobs
						school & higher ATAR		
				food, culture, language	attractions			
					ability to learn and speak			
					and pronounce all the words	able to recognise the difference in English and French		able to recognise the difference
B-10-L-01	L	Indonesian	F	learning				
				reading	structure			
				writing	logic	easy to learn		easy to learn
				speaking				
				culture	religion			
					how they live			
					values	better understanding of indonesia itself		better understanding
				opportunities	more	jobs requiring indonesian speakers		
						better qualified		
				community	safe environment	makes me willing to learn		
					good relationships			
					enjoyable learning environment	makes it fun to learn		
B-10-L-02	L	Indonesian	F	knowledge		improves memory skills		improves memory
						improves intelligence across different subjects		improves intelligence
						better understanding of how complicated the English language is	concepts appear to related directly to propositions	better understanding
				opportunities		looks good on resume	with little to no intermediate relationships	
						work collaboratively with others		
						for interesting and exciting work		
				communication	travelling opportunities	improved speaking skills in both English and Indonesian		improved speaking
						communicate with different people with a different language		
				culture		understanding similarities and differences to Australia		understanding similarities and differences
B-10-L-03	L	French	F	words	grammatical rules	gives one the ability to participate in the most important parts of language		
					tense			
					practical perspective			

School B – Phase 1 Concept Map Data Reduction Table – languages participants								
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**	**Notes**	**Reduced propositions**
					speaking, listening, writing			
				culture	travel links to this			
					different worlds	French is more than a language		
					cultural monuments			
					art and history	understanding other people		understanding
					food			
					beliefs			
					learning new ideas	makes people feel small		
				travel	part of learning about culture			
					communicatio n and culture	after I joined I realised so many artists were french, and I love painting		
					along with words	to experience culture you must travel		
				everyday life is connected	to french			
					helps you understand culture			
				benefits	helped	helped my communication in English	"benefits" clearly listed as a concept	
					curiosity	makes learning feel like self-help		learning feel like self-help
					creativity benefit	personally makes me more creative		makes me more creative
						makes links between everyday life & language which is why it's easy to learn		
						gives you more versatility		versatility
						allows you to understand		understand
						makes me more organised in thought		more organised
				communication	allowing secrets	learning how 2 communicate effectively can only come with travel		learning
						helps communication in English & learn, or rather remember more words in existing vocab due to French		helps
						easiest to relate because it's a European language		
						helps us understand how different our world is		
						because I am a creative person, taking an interest in writing, painting, and language learning		creative person
						I took an interest in French		
						gave me ideas for painting		gave me ideas
						I like French because of the key concepts		
						lets me connect with more		connect

School B – Phase 1 Concept Map Data Reduction Table – languages participants								
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**	**Notes**	**Reduced propositions**
						people		
						being able to express ideas to people not from your country/home		express ideas
						being able to learn about culture		learn
				why (did I join)?	improvement	interest in improving myself	subordinate concept	improving
					interest	interest in key ideas		
					benefits	interest in improving my world view		improving
						love of learning		learning
						helped me stay connected to year 8, as I learned Italian at my old school		connected
B-10-L-04	L	French	M	understanding the world	builds	understanding of our culture		
					leads to			
				learning about others			Relationships in this response	
				culture	represented by		are mostly enabling relationships	
				speaking	slang, forms, patterns	deepening understanding of our own language, beauty	helps to	deepening understanding
						unique but similar	used to	
				learning a language	requires learning about		builds	
					listening	using both sides of the brain	requires	both sides of the brain
					using both sides of the brain	helps with adapting, making you a better person	requires and helps with	adapting
						is a life skill	needed for	life skill
					requires and helps with	creativity		creativity
					reading	requires knowing how to relate to things		knowing how to relate
						problem solving		problem solving
				understand language use	helps with	STEM		
				understanding differences	helps with	seeing things differently		seeing things differently
						coping with change		coping with change
						life		
						to know you and your surroundings		to know you and your surroundings
B-10-L-05	L	Russian	F	culture	etymology			
					vocabulary			
					politics			
					values			
					expression			
					literature			
					films	none found		
					poetry			
					structure			
					syntaxes			
					emtion			
					music			
				identity	family			
					namesake			

School B – Phase 1 Concept Map Data Reduction Table – languages participants								
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**	**Notes**	**Reduced propositions**
				geography	Volga (river)			
B-10-L-06	L	Tamil	F	social issues	caste system	why there is one / why is it still prevalent?		
					protests	knowing what is going on		knowing what is going on
					respect			
				culture	festivals	kinda ties into history		
					food			
				history	lost/hidden	old artefacts that have shaped the culture		shaped culture
				temples	how the two correlate			
				empires				
				mother tongue	letters	instead of just speaking & stuff I wanted to know where it came from		
					literature (lost)	because it is the oldest living language		
						broaden my vocab		

Table 71 School B - Phase 1 Concept Map Data Reduction Table - technology participants

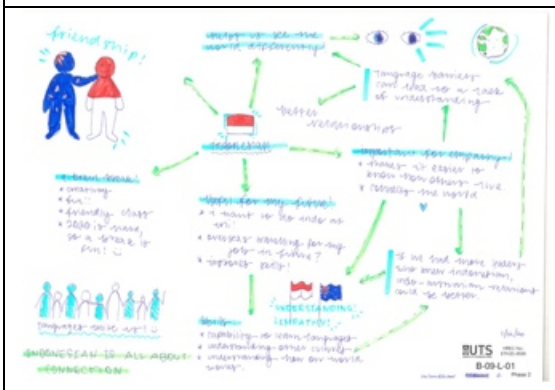
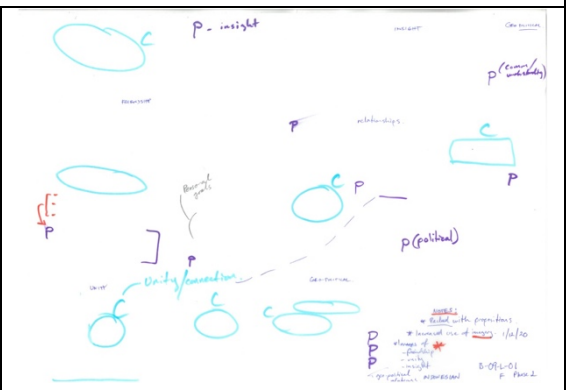
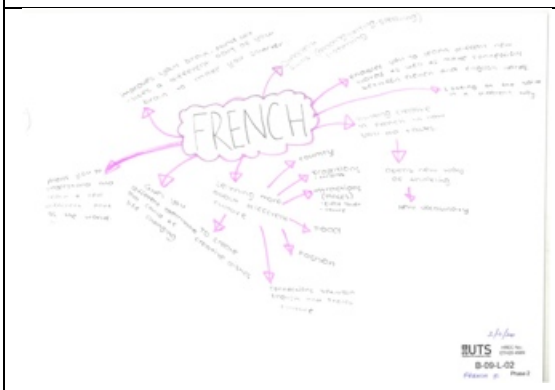
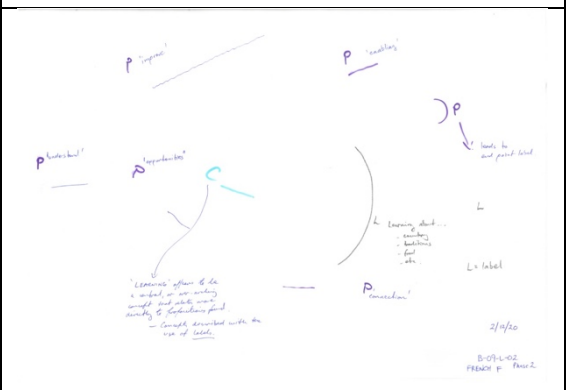
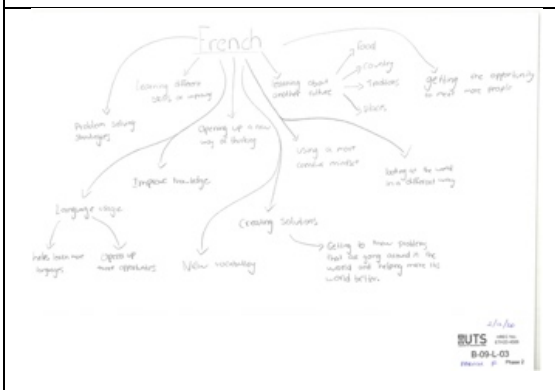
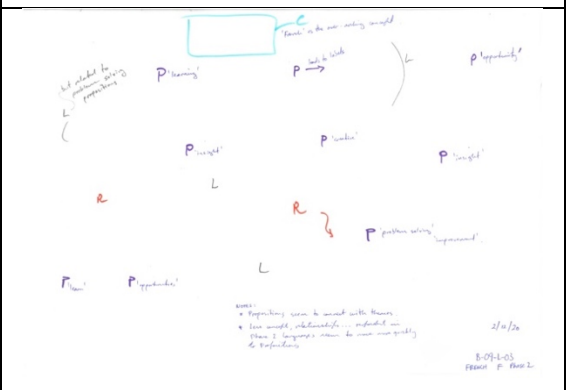
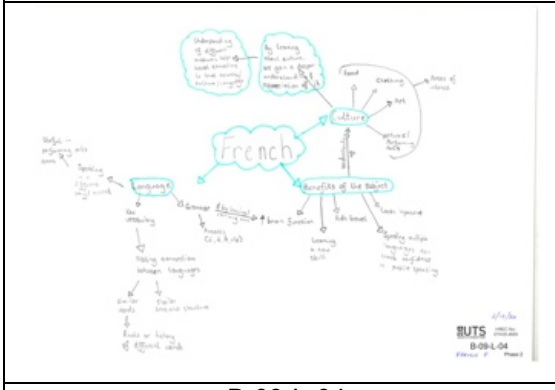
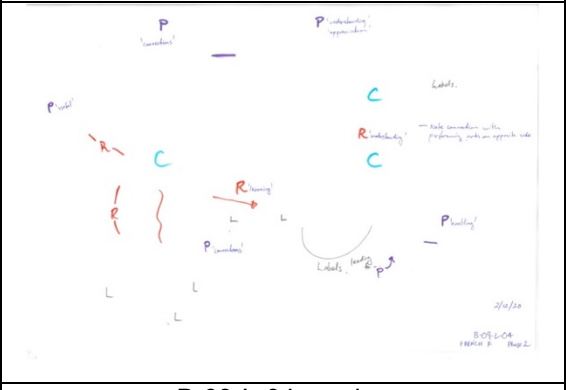
School B – Phase 1 Concept Map Data Reduction Table – technology participants								
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**	**Notes**	**Reduced propositions**
B-Teacher-01	T	Design and Technology	M	problems	finding			
					solving			
					empathy			
					reframing			
				thinking	creative			
					critical			
					convergent			
					divergent			
					lateral			
					analogy			
					storytelling			
				real world	humanities	making the world a better place		making / better
B-10-T-02	T	Design and Technology	M	STEM				
				science				
				research	finding a solution / reasoning			
				testing	trying new things / failure is OK			
				technology				
				building	how does it help?			
					what is the purpose?			
					to help do what we do	better, efficient ways of doing things	theme of help emerging	better
				engineering				
				building	implementing	combining minds to create the best product	human factors emerging	minds / better / best
						using tech to design product for the people		
				reason behind building	why	what is the reason for what you have built?	**why**	why
					using maths to help build		help	
				maths				
				data	with help of the research			
					how data helps us		storing human factors	
				formula	implementing maths to help	what does the maths tell us after reviewing results?	in this response	
						interest in engineering and building things		engineering
						wanting to build on skills and discover new ones		Build, discover skills
B-10-T-01	T	Design and Technology	M	STEM				

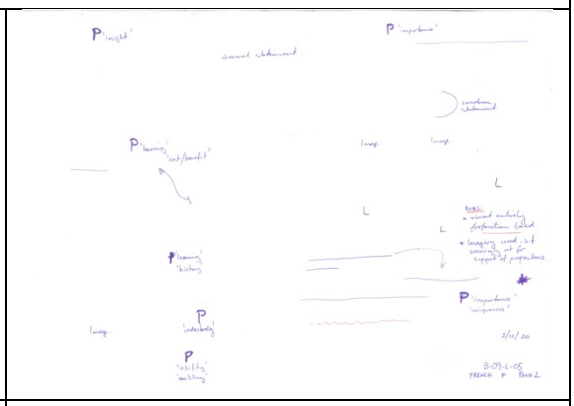
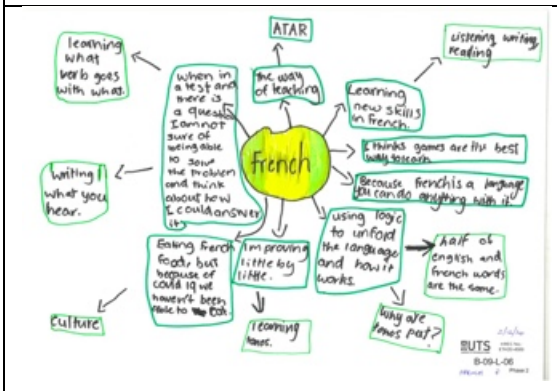
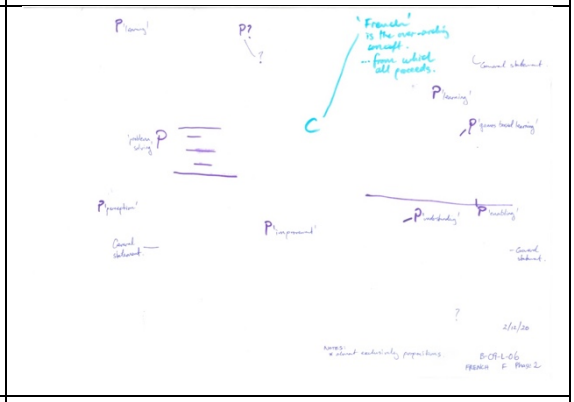
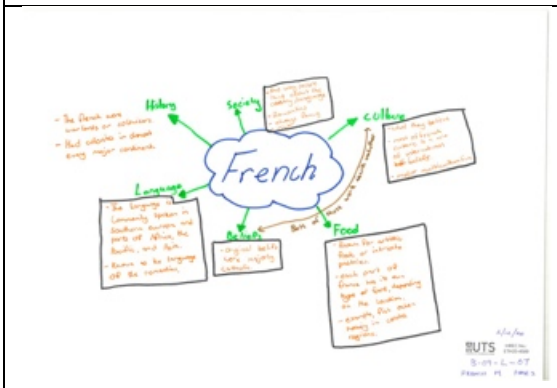
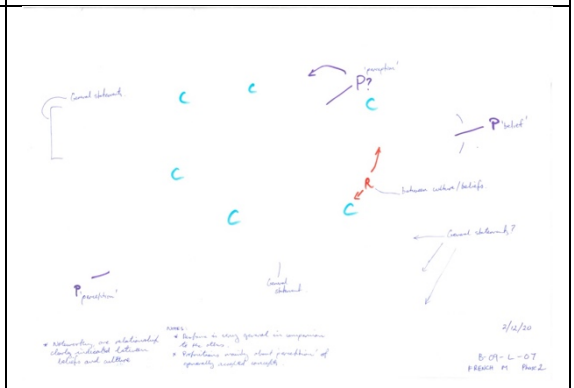
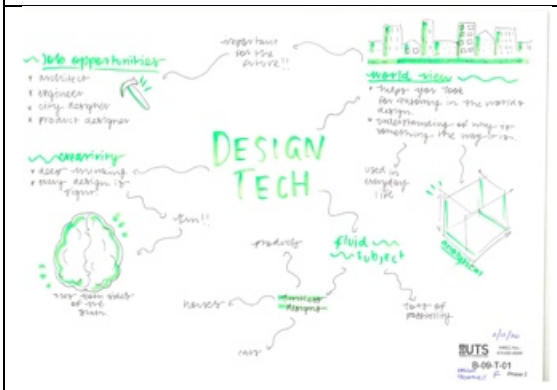
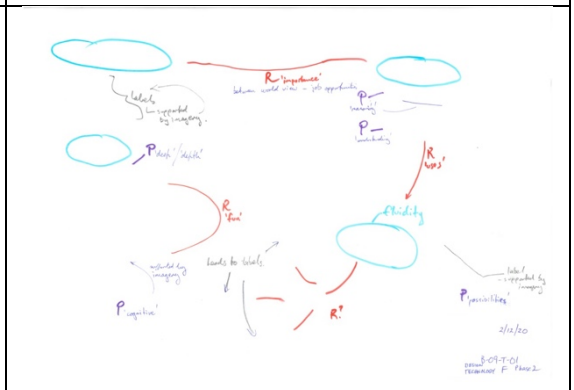
School B – Phase 1 Concept Map Data Reduction Table – technology participants								
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**	**Notes**	**Reduced propositions**
				practical	experience / challenging			
				design	creativity			
					outside the box			
					art			
					decoration			
					advertisement			
					popularity			
				science	problem solving			
					critical thinking			
				thinking for the future	environment			
					recycling			
					ethics	teaching the younger generation		teaching
				work	future			
					jobs	manual / automation		automation
						way more to it than designing and practical components		more to design
						design is whatever you picture it as		design
					science and maths	two very different ends of the spectrum		different
B-10-T-03	T	Design and Technology	M	STEM / Technology	requires	what I thought prior to the course		
						what the client wants		client
					hands on			
					less thinking			
					planning			
				what the client wants				
				ergonomics				
				critical thinking				
				future jobs				
				critical thinking				
				ergonomics				
B-10-T-04	T	Design and Technology	F	STEM Education				
				electronics				
				numbers				
				how				
				understanding	language barriers	helping people		helping
				where	who can get it	helping people		helping
				global	culture			
					family			
					friends	all are in the sciences		
				exploring	peer review			
					research			
				why				
B-09-T-03	T	Design and Technology	M	design technology	< led me to	< interest in aviation		
				digital design	conceptual design making	solving problems through designs using creativity	linkage of 'includes'	problem solving
				conceptual design		using STEM technologies	Design Technology 'includes'	
				physical design	includes	making things in the workshop	digital and physical design	making
				hands on		physical skills and techniques		skills / techniques
B-09-T-01	T	Design and Technology	M	hands on	creative			
				new	inspire			
					I thought	I thought this	relationships	

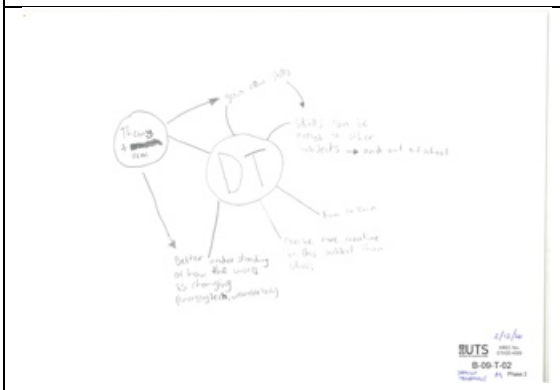
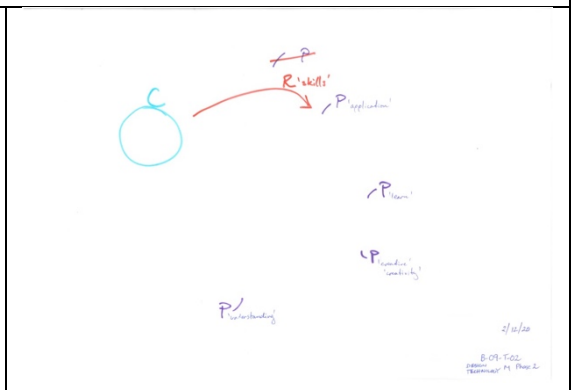
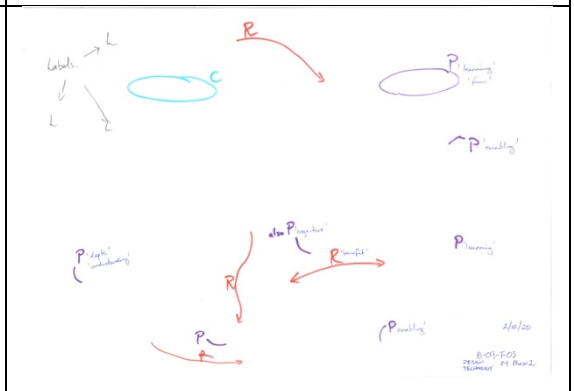
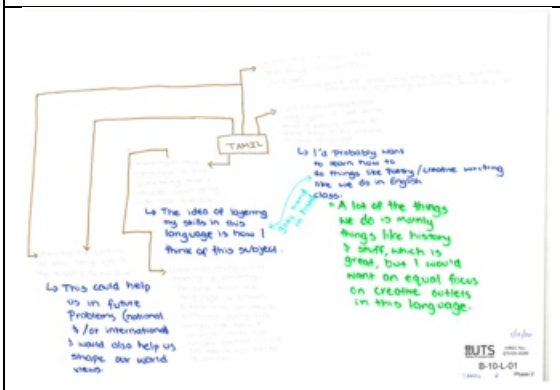
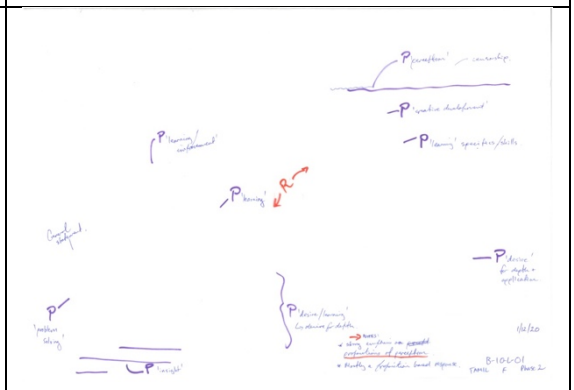
School B – Phase 1 Concept Map Data Reduction Table – technology participants								
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**	**Notes**	**Reduced propositions**
						subject we would have more hands on task	appeared more as	
					I chose	I chose Design tech for the hands on task wood working	common themes within the	
					I wish	I wish this subject could be like I thought instead of lots of theory and listening	proposition statements	
					instead			
					I have started	makes me more creative and makes me calmer person due to it being relaxing to design		
						and letting my mind go anywhere		
B-09-T-06	T	Design Technology	F	Design Tech				
					discoveries	informs the world		informs
				fluid subject	unconstrained	opportunities galore		opportunities
				creativity	originality	unlimited designs in the world, many possibilities		unlimited / possibilities
					problem solving			
					things like climate change			
					problem solving			
					helping me	changing the future		future
					relaxing	brain break between other more fact based subjects		
				opportunities	jobs		notably no propositions stated for jobs	
				design	digital			
					physical			
						name a problem in today's world that can't be solved by design/STEM		problem solving
						there's always more		more
B-09-T-04	T	Design Technology	M	STEM		relates to all subjects	response indicates STEM at the top of the hierarchy	relates
						allows me to be more open with my own ideas		ideas
					digital and physical	learn how to use new techniques		learn / techniques
					put them into practice			
					creativity	allows me to work with my hands > I can use new tools		work with hands / tools
					problem solving			
					real life & theoretical issues			
B-09-T-05	T	Design	F	assignments	too much			

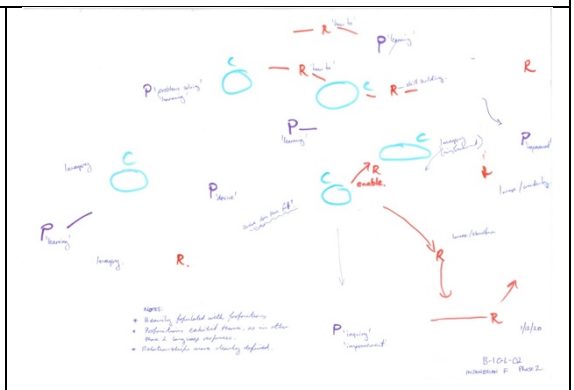
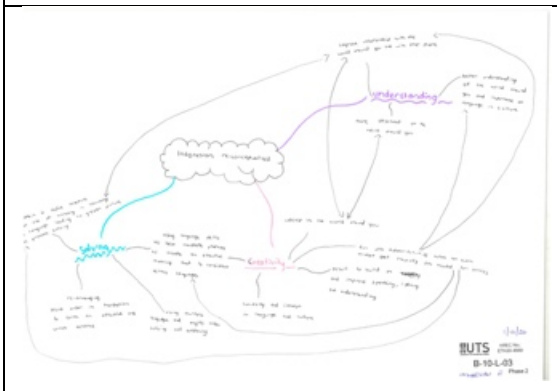
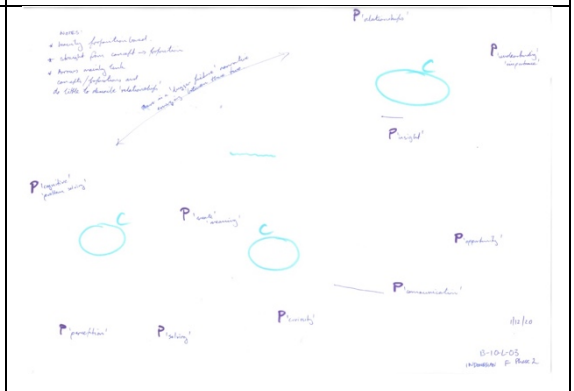
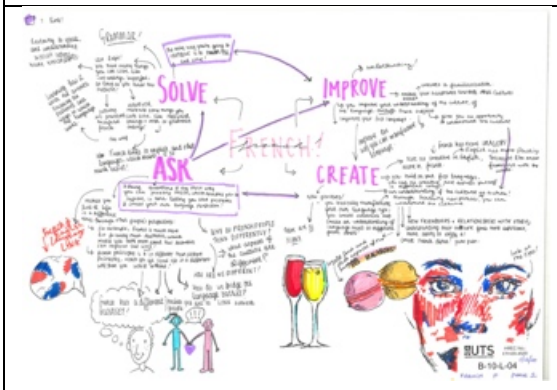
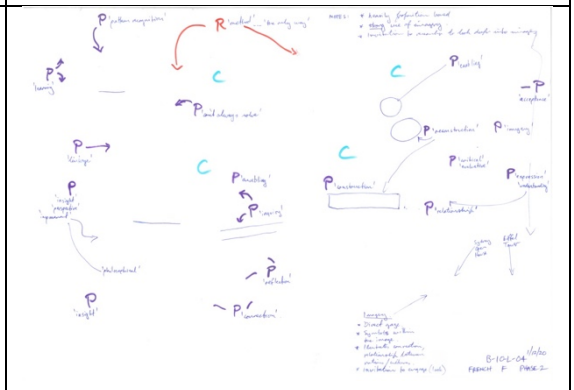
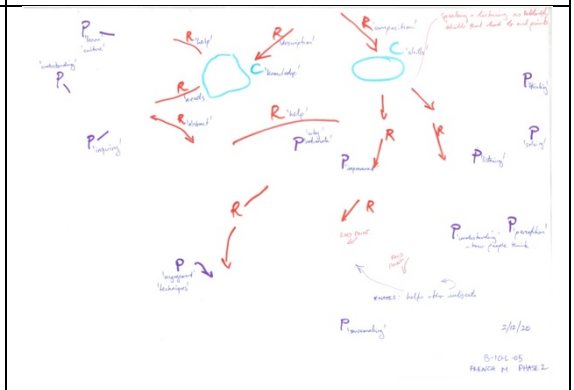
School B – Phase 1 Concept Map Data Reduction Table – technology participants								
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**	**Notes**	**Reduced propositions**
		Technology			writing			
					information reports			
					essays			
					too much in class	work load		
				design process				
				only a little bit	hands on			
					digital	I thought this subject would be mainly design and the design process, but it was mostly research assignments		
				creative thinking	creative restrictions / freedom	not much creativity in class		creativity (less)
				problem solving				
					strict teacher			
					not fun anymore	I would not choose this subject again		
				machinery	wood work			
					safety rules	COVID-19 stopped most of our practical work		practical
					tools	can't use most of the machines, y11 & 12 only		practical
					material usage			
					always have to share	running low / don't have the materials		
B-09-T-02	T	Design Technology	M	subject choice	already good at DT			
					didn't want to do other electives			
					I enjoy creative subjects	never enjoyed languages or music as electives		
				grades	would be easy to get along with	my family has had a history of people …working…engineering tasks or jobs		history / engineering jobs
						I'm rather good at DT and creative subjects		creative
				impacts		many jobs will require concepts learned in DT	no relationships shown for these propositions	jobs
						engineering is a possible career from DT		jobs / career
						I always wanted to do Design Tech	no concept or relationship for this proposition	desire
						I rather enjoy building things, hand-working and metal working		making / practical
				friends doing DT	wanted to have friends in classes		relationship connects 'grades' and 'friends'	

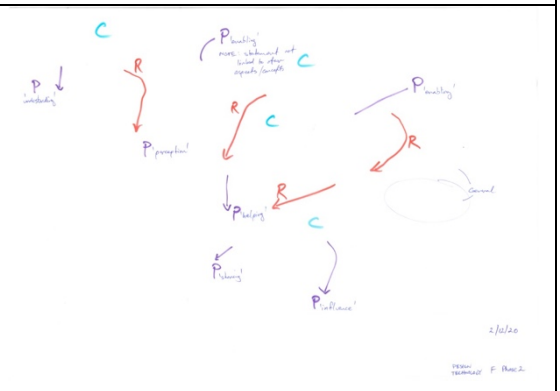
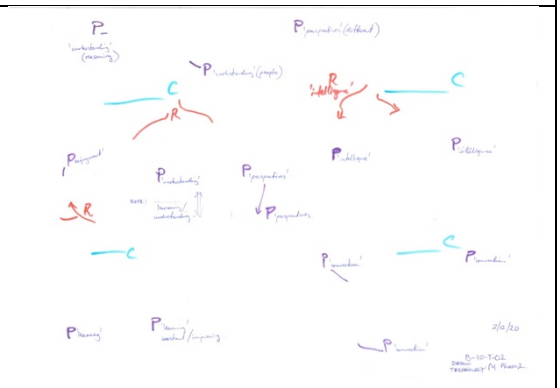
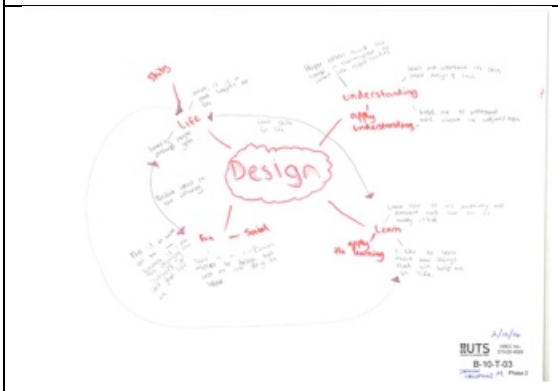
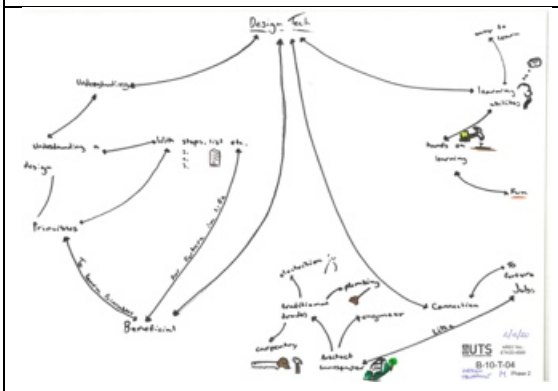
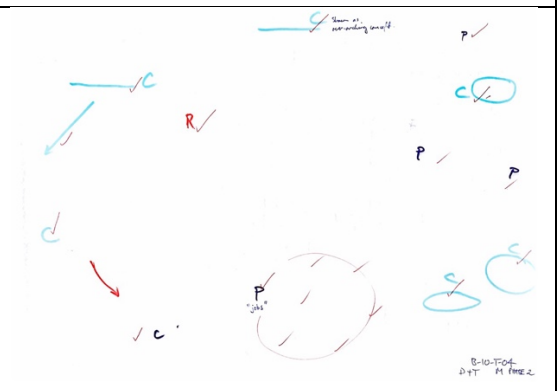
Table 72 School B - Phase 2 Concept Maps and Analysis Overlays

School B – Phase 2 Concept Maps and Analysis Overlays	
	
B-09-L-01	B-09-L-01 overlay
	
B-09-L-02	B-09-L-02 overlay
	
B-09-L-03	B-09-L-03 overlay
	
B-09-L-04	B-09-L-04 overlay

School B – <u>Phase 2</u> Concept Maps and Analysis Overlays	
	
B-09-L-05	B-09-L-05 overlay
	
B-09-L-06	B-09-L-06 overlay
	
B-09-L-07	B-09-L-07 overlay
	
B-09-T-01	B-09-T-01 overlay

School B – Phase 2 Concept Maps and Analysis Overlays	
	
B-09-T-02	B-09-T-02 overlay
	
B-09-T-03	B-09-T-03 overlay
Students absent for phase 2	
B-09-T-04	
Students absent for phase 2	
B-09-T-05	
Students absent for phase 2	
B-09-T-06	
	
B-10-L-01	B-10-L-01 overlay

School B – <u>Phase 2</u> Concept Maps and Analysis Overlays	
	
B-10-L-02	B-10-L-02 overlay
	
B-10-L-03	B-10-L-03 overlay
	
B-10-L-04	B-10-L-04 overlay
	
B-10-L-05	B-10-L-05 overlay
Students absent for phase 2	

School B – <u>Phase 2</u> Concept Maps and Analysis Overlays	
B-10-L-06	
	
B-10-T-01	B-10-T-01 overlay
	
B-10-T-02	B-10-T-02 overlay
	
B-10-T-03	B-10-T-03 overlay
	
B-10-T-04	B-10-T04 overlay

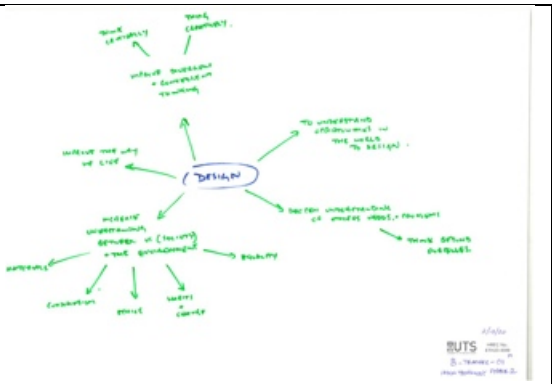
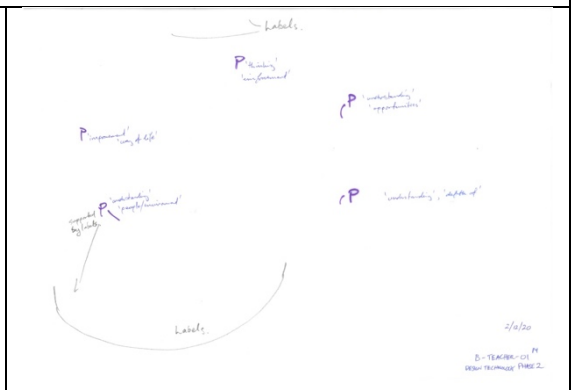
School B – <u>Phase 2</u> Concept Maps and Analysis Overlays	
	
B-Teacher-T-01	B-Teacher-T-01 overlay

Table 73 School B - Phase 2 Concept Map Data Reduction Table - technology participants

School B – Phase 2 Concept Map Data Reduction Table – technology participants						
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**
B-Teacher-01	T	Design and Technology	M	design	straight to propositions	improve divergent and convergent thinking
						improve the way we live
						increase understanding between us (society) and the environment (materials, consumerism, ethics, habits & change, equality)
						deepen understanding of others needs and problems, think beyond ourselves
						to understand opportunities in the world to design
B-10-T-01	T	Design and Technology	F	different ideas	new skills	helping everyone with it
				creativeness	observations of the human and natural world	relate to their point of view
				building stuff	new ideas	understanding other people
				innovation		willingness to learn, and the to share
						think of it then make it
						balance of power and influence due to use of things
						languages can be helpful
B-10-T-02	T	Design and Technology	M	understanding	to gain understanding	understanding people's reasoning for doing something that way
				improvements	intelligence	different people have different perspectives within design that can have many differen outcomes
				learn	learn	many people gain enjoyment out of learning new things
				connect		understanding new concepts within technology
						forces different perspectives to understand design greater
						technology has many new things for people to learn
						constantly learning more and becoming better at previous skills
						gives you different perspectives which enhance learning abilities for many other things
						technology is a great way of connecting with other people
						through tech we can design and create new things that bring people closer
						having connection to things you build
						with practise and greater understanding, intelligence in the subject grows greater and greater
						can make you think about things differently,helping gain intelligence in other scenarios
B-10-T-03	T	Design and Technology	M	design		people often think the course is stereotyped to certain job opportunities
				applying understanding		learn and understand life skills about design and tech
				life skills		helps me to understand more about the subject / topic
				applying learning		learn how to use machinery and different tools that can be handy in life
				fun, social		I like to learn about new things that can help me in life
						overall it is a good subject for life
						benefits people around you
						positive effect on your wellbeing
						(positive wellbeing) this is a must for me because if I am not enjoying the subjects it isn't good for me
						there is a fun social aspect to design, that's why I do the subject
B-10-T-04	T	Design and Technology	F	design and tech	to learn principles	easy to learn

School B – Phase 2 Concept Map Data Reduction Table – technology participants						
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**
				understanding	understanding, with steps, lists...	hands-on learning
				principles		fun
				learning abilities		jobs (traditional trades, electrician, carpentry, plumbing) engineer, architect, landscaper
				future jobs		beneficial
				connection		
B-09-T-01	T	Design and Technology	F	job opportunities	important for the future (world view-job opportunities)	uses both sides of the brain
				creativity	fun	lots of possibilities
				world view	limitless designs	helps you look for reasoning in the world's designs
				fluid subject	used in everyday life	understanding of why is something the way it is
				analytical		
B-09-T-02	T	Design Technology	M	theory & prac	gain new skills	skills can be applied to other subjects and out of school
						fun to learn
						can be more creative in this subject than in others
						better understanding of how the world is changingd (emerging tech, wearable tech)
B-09-T-03	T	Design and Technology	M	intelligence across subjects	time management	fun to learn
					research skills	makes it easier to learn
					writing skills	theory, learning about design, emerging and current technology
					hands-on workshop skills	allows me to be more creative
					might benefit both sides of the brain	deepens understanding of the world and technology
						helps de-stress
B-09-T-04	T	Design Technology	M			absent for phase 2
B-09-T-05	T	Design Technology	F			absent for phase 2
B-09-T-06	T	Design Technology	F			absent for phase 2

Table 74 School B - Phase 2 Concept Map Data Reduction Table - languages participants

School B – Phase 2 Concept Map Data Reduction Table – languages participants

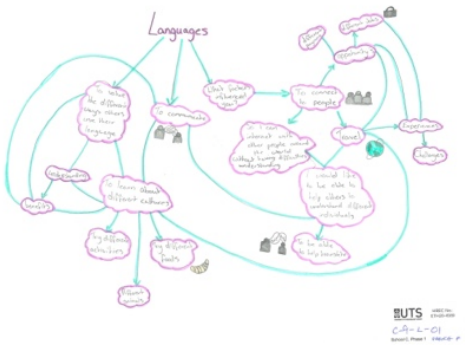
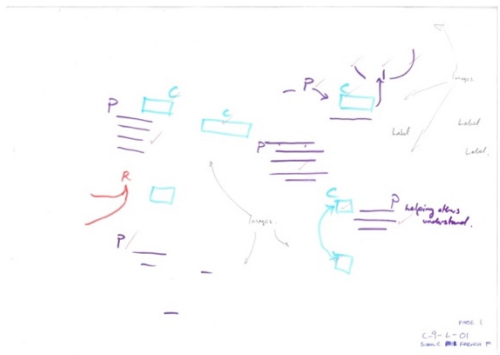
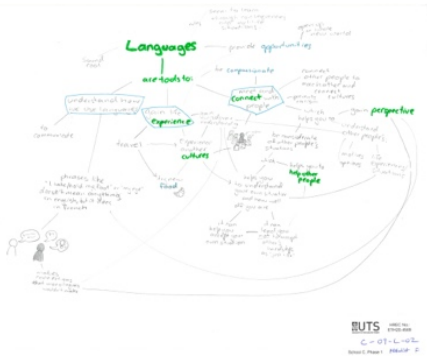
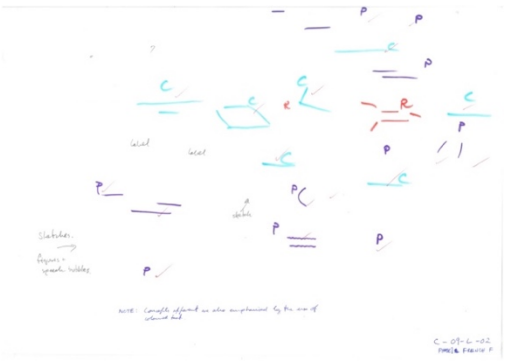
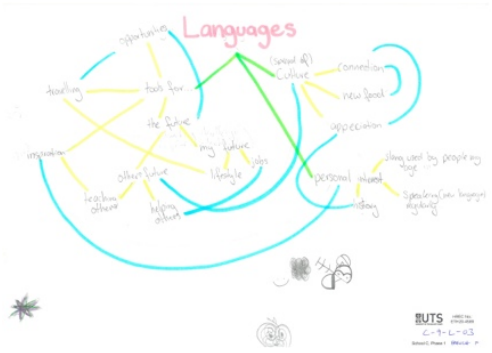
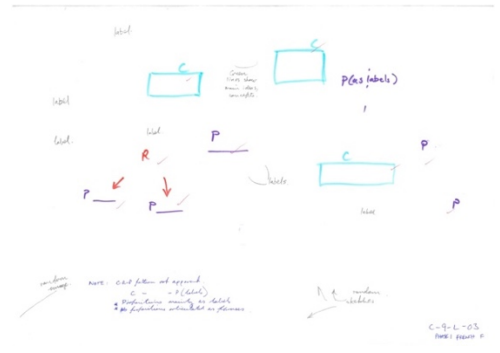
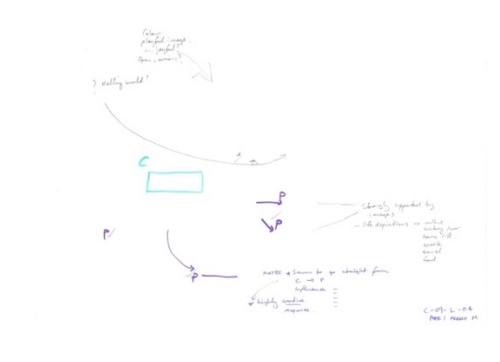
Participant	Cat.	Subject	G	Concepts	Relationships	Propositions
B-09-L-01	L	Indonesian	F	Friendship		I want to do Indo at uni
				brain break	creativity	overseas travelling for my job in the future
					fun	
					friendly class	2020 is hard, so a break is fun
						helps us see the world differently
				future		
				unity		language barriers can lead to a lack of understanding
				connection		makes it easier to know how others live
				skills		connects me to the world
				understanding		capability - to learn languages
				empathy		understanding - other cultures
						understanding - how our world works
						improves skills
						if we had more leaders who knew Indonesian, Indo-Australian relations could be better
B-09-L-02	L	French	M	Learning more (about culture)		improves your brain, mindset
				country		uses a different part of your brain to make you smarter
				traditions		enabling you to learn different words as well as make connections between French and English words
				attractions		Thinking creative in French in how you do tasks
				food		opens new way of thinking
				fashion		gives you different opportunities that could be life changing
						allows you to understand and learn a new different part of the world
B-09-L-03	L	French	F	French	language use	Learning, different skills, problem solving
					creating solutions	open up a new way of thinking
						learning more languages
						open up more opportunities
						learning about another culture, food country traditions places
						opportunity to meet more people
						using a more creative mindset
						looking at the world in a differen way
						getting to know problems in the world and helping make things better
B-09-L-04	L	French	F	language		understading of different cultures helps boost connections to the country, culture, language
				culture	understanding	by learning about culture we gain a deeper apprreciation of it
				benefit of the subject	speaking in a different way	speaking multiple languages can boost confidence in public speaking
					new vocabulary	useful in performing arts
					learning / revising	
					making connection between languages	
B-09-L-05	L	French	F	no discernable concetps	no discernable relationships	different people perceive hands-on learning and typical in class learning differently, often in-class learning can be more fruitful but less enjoyable.
						The course can be tiresome and content heavy. Ultimately it is beneficial to our overall understanding of all the components of French.
						Understanding French grammar and literacy helps with understaning our English language and history
						Every component counts, whether it is how to shop or how to book for a youth hotel.

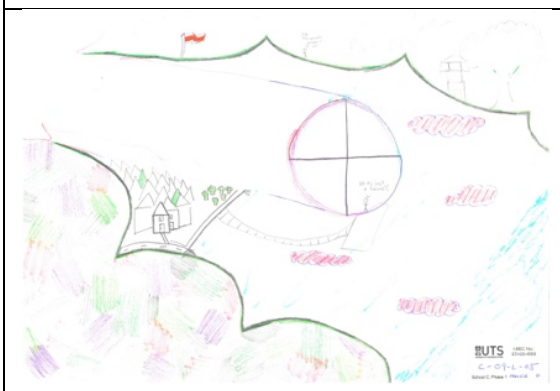
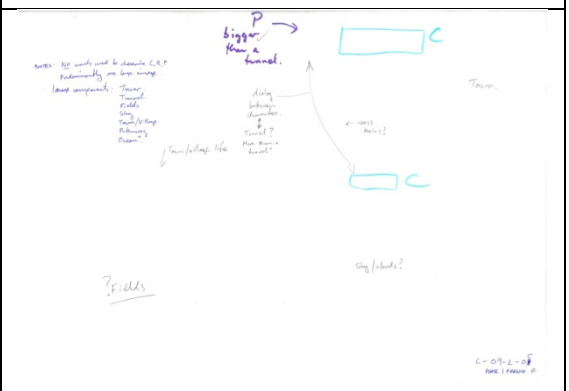
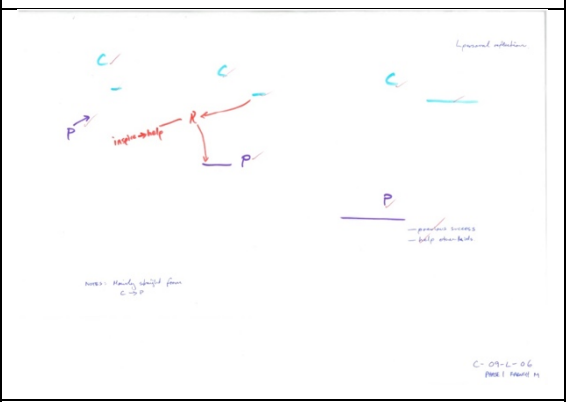
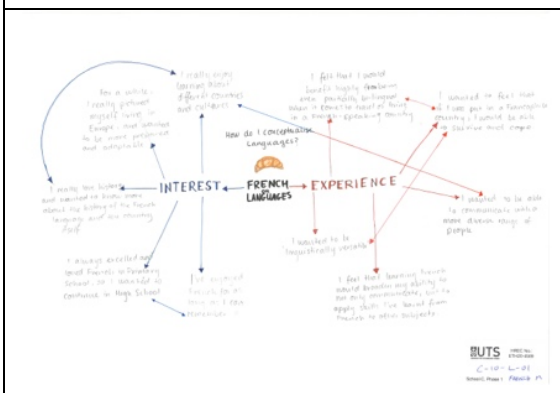
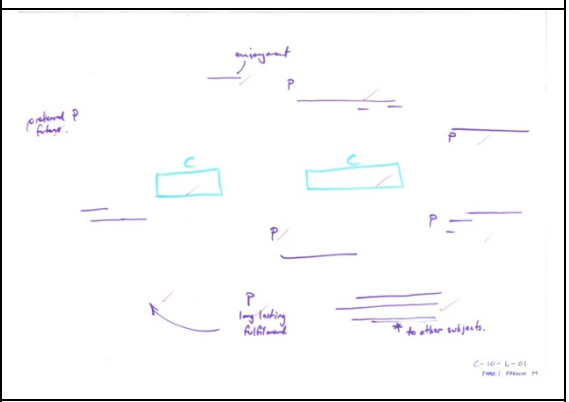
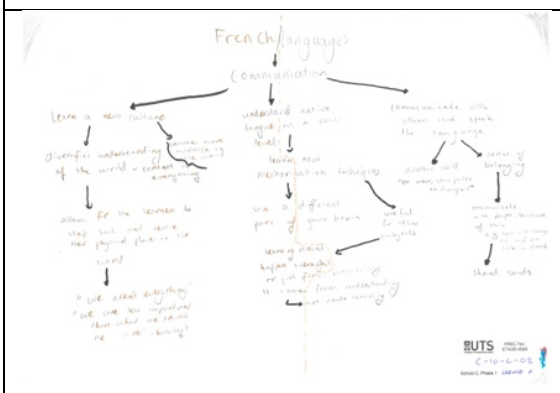
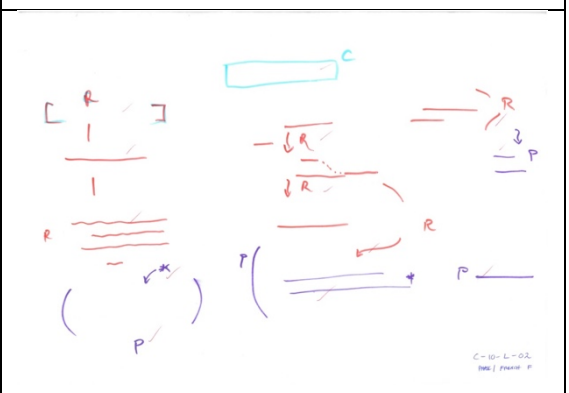
School B – Phase 2 Concept Map Data Reduction Table – languages participants						
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**
						Everything we learn in French when it concerns the language itself, is important... ...unlike other subjects all the knowledge we obtain is important with very little exceptions.
						Learning about culture helps you understand life in France more.
						Learning about grammar and reading etc. is important for our speaking abilities... Helping us communicate better in France, and brain growth.
B-09-L-06	L	French	F	French		writing what you hear
				(over arching concept)	the way of teaching (leads to an ATAR)	improving little by little
						I am not sure of being able to solve the problem
						Learning new skills in French
						I think games are the best way to learn
						Because French is a language you can do anything with it.
						Using logic to unfold the language and how it works.
						half of English and French words are the same
B-09-L-07	L	French	F	history		French, the language of romantics
				society		most of French culture is a mix of international beliefs
				culture		major multiculturalism
				food		The French', romantics, always fancy, rich
				beliefs		
				language	culture and beliefs work with each other	
B-10-L-01	L	Tamil	F	layering skills		the idea of layering my skills in this language is how I think of this subject
					goes hand in hand	I'd probably want to learn how to do things like poetry/creative writing like we do in English class.
						I would reconceptualise languages in the sense that I would want to learn how to be creative in this language
						(goes into the history) but not censoring anything as some teachers do
						A lot of things we do is mainly things like history and stuff, which is great, but I would an equal focus on creative outlets in this language.
						This could help is in future problems (national / international) and would also help us shape our world views
						Going into things like how to change words into written format woud be a bit better and useful.
						Improving in this language is also something that I consider when going into this subject.
B-10-L-02	L	Indonesian	F	solve		to learn new skills
				skills		solving is a major part of Indo because it is how we learn (from mistakes) and improve our skill
				improve	ask in order to improve	learning about indo culture whilst learning the language
				ask	aiming for	what I want
				culture	similar to	another key component because by asking questions (like the one above) we improve our skill
				creativity	how to	overall improving my fluency in Indo
					asking questions to learn more	Everything leads back to improving or learning skills
					in terms of how we learn	
B-10-L-03	L	Indonesian	F	understanding		improve relationship with the world around you and with other people
				solving	no discenrable relationships	better understanding of the world around you and importance of language in culture
				creativity	respondent makes direct links between concepts and propositions	fun job opportunities where an open mindset and creativity are needed for success
						pursuit to build on and improve speaking , listening and understanding
						curiosity and interest in language and culture
						using language skills to best translate phrases to create an effective meaning that is consistent across languages
						using multiple languages and angles when solving and questioning

School B – Phase 2 Concept Map Data Reduction Table – languages participants						
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**
						brain is active because of use of memory in learning a language leading to greater picture in problem solving
						re-arraning word order in translation to form an effective and correct sentence
B-10-L-04	L	French	F	solve	straight from concept to proposition	learning to speak, understand patterns
				improve		some things cannot be solved like irregular endings, verbs, grammar
				ask		French links to other English and other languages which makes it so much easier
				create		makes you look at life in a different way through other people's perspectives
						France is much more eco friendly than Australia which makes you think more about how Australia can improve and WHY
						French philosophy is a lot different than Western philosophy, makes you ask about life in a different way than you would without
						French has a different mindset
						How do we bridge one language barrier?
						Makes you able to link between people.
						Why do French people think differently?
						What aspects of the culture are different?
						How are we different?
						Makes your acceptance to other cultures better.
						you improve you understanding of the culture and the language through these subjects.
						Improve the way you can manufacture language.
						English has more fluidity because I'm more familiar with the words.
						You basically manufacture your own language type.
						Through learning new phrases you can understand the culture.
						New friendships and relationships with others.
						Understanding their culture gives you more experience, more ability to enjoy it.
						Not as creative in English, more in French.
B-10-L-05	L	French	F	knowledge	description	think in a different way
				skills	composition	solve problems
					help	listening to others and take it in
					needs	seeing things in a different way
					abstract	helps subjects like science
					reading, speaking, helps	helps subjects like English
					listening helps	making sense
						engaging the person
						helps to learn about culture
						helps to learn about yourself
						logic to ask why
B-10-L-06	L	Tamil	F			absent for phase 2

Appendix H – School C, Phase 1 & 2 Concept Maps, Overlays, Data Reduction Tables

Table 75 School C Phase 1 Concept Maps and Analysis Overlays

School C – <u>Phase 1</u> Concept Maps and Analysis Overlays	
	
C-09-L-01	C-09-L-01 overlay
	
C-09-L-02	C-09-L-02 overlay
	
C-09-L-03	C-09-L-03 overlay
	

School C – Phase 1 Concept Maps and Analysis Overlays	
C-09-L-04	C-09-L-04 overlay
	
C-09-L-05	C-09-L-05 overlay
	
C-09-L-06	C-09-L-06 overlay
	
C-10-L-01	C-10-L-01 overlay
	
C-10-L-02	C-10-L-02 overlay

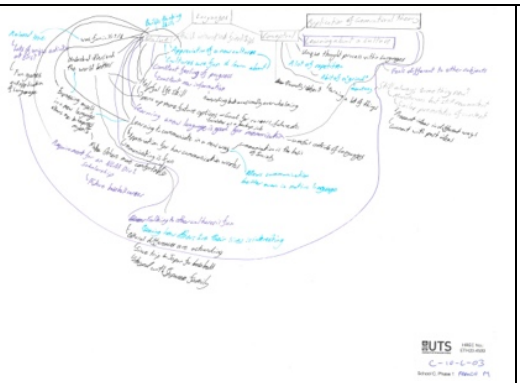
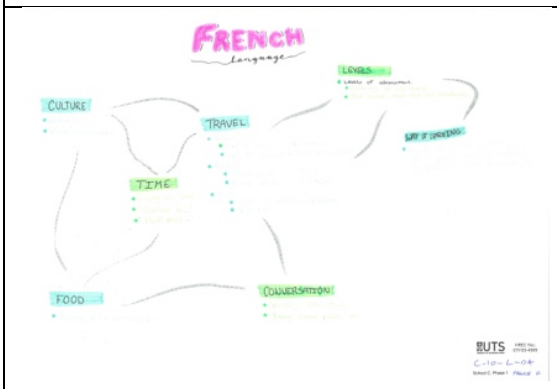
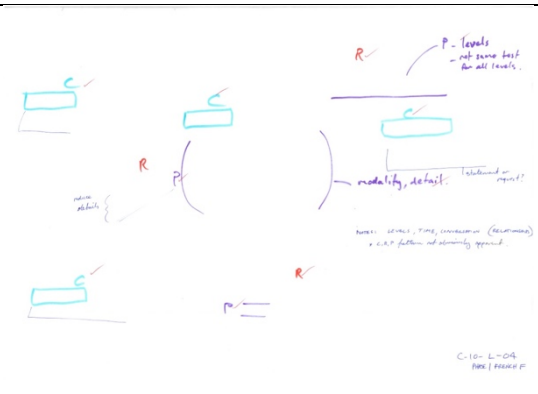
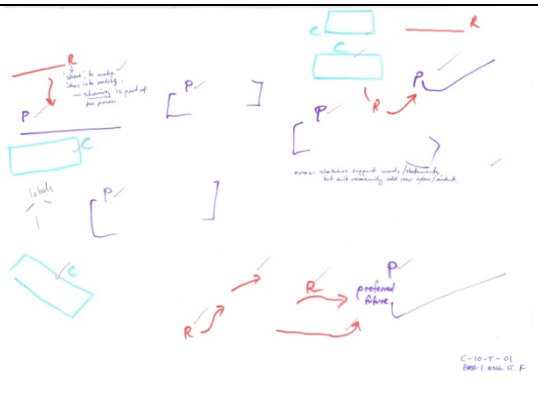
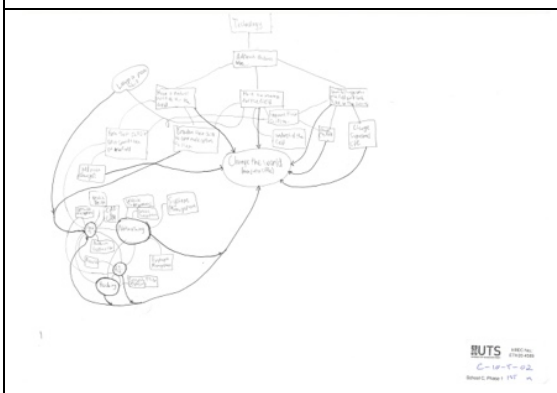
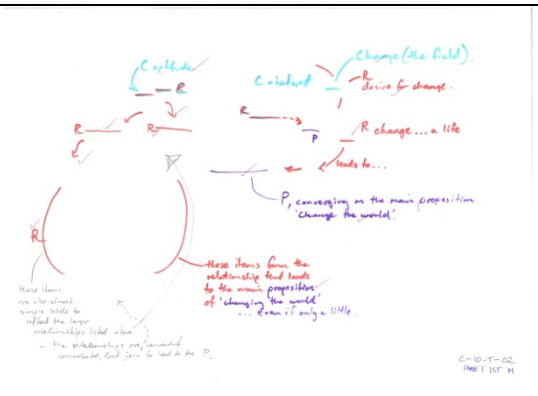
School C – <u>Phase 1</u> Concept Maps and Analysis Overlays	
	
C-10-L-03	C-10-L-03 overlay
	
C-10-L-04	C-10-L-04 overlay
	
C-10-T-01	C-10-T-01 overlay
	
C-10-T-02	C-10-T-02 overlay

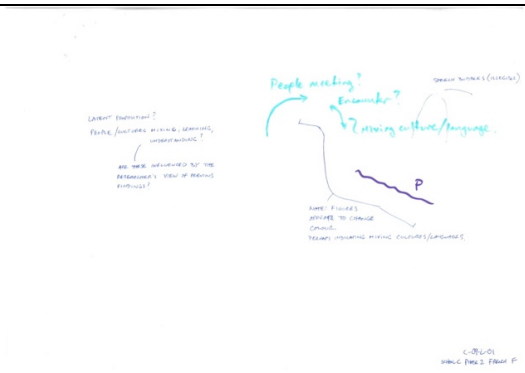
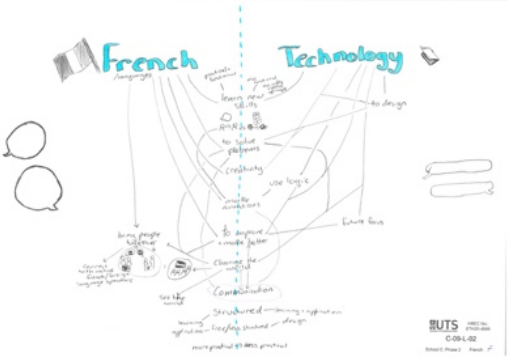
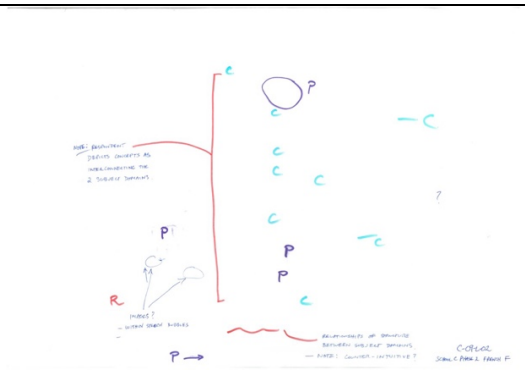
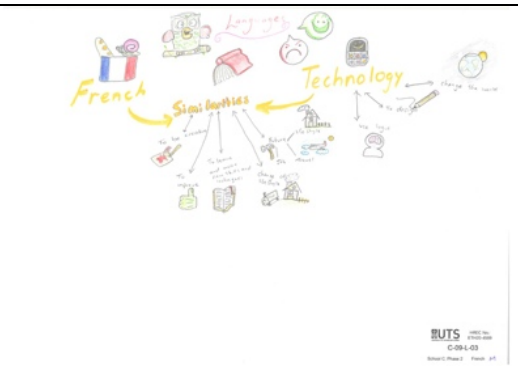
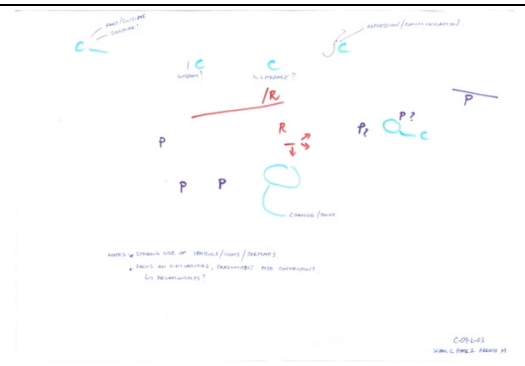
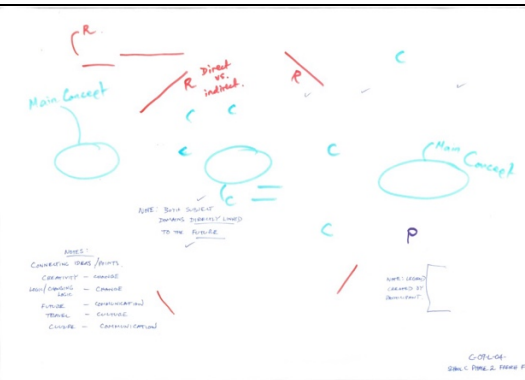
Table 76 School C - Phase 1 Concept Map Data Reduction Table

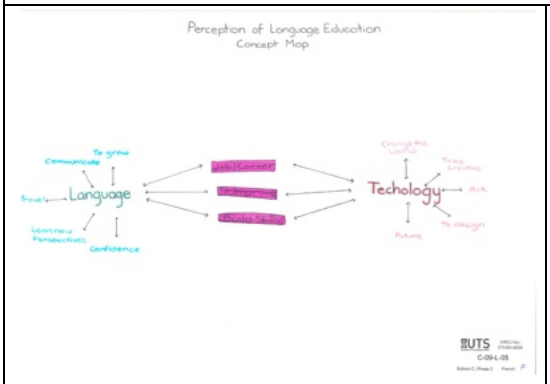
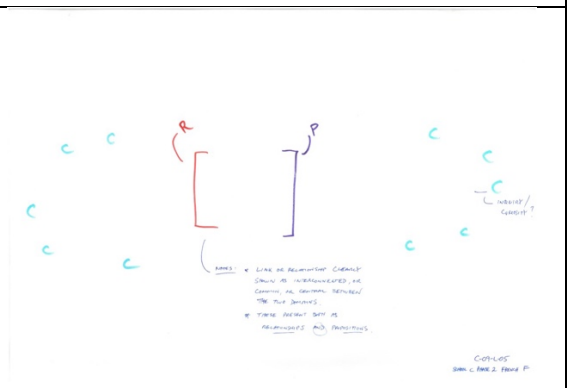
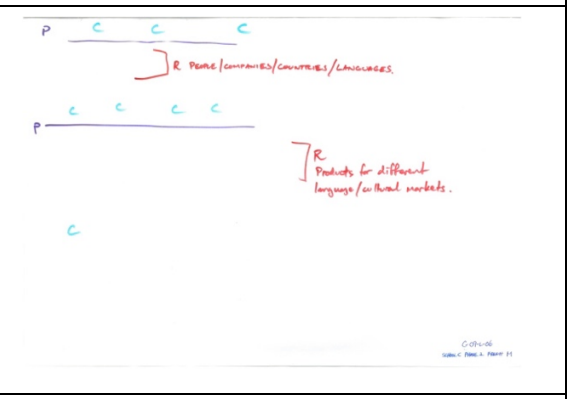
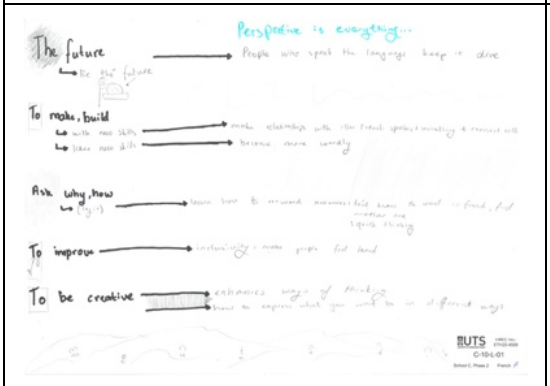
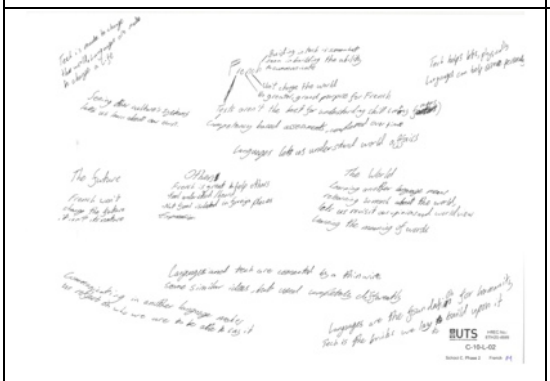
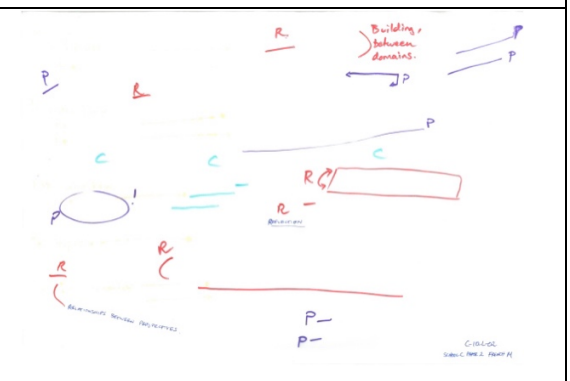
School C – Phase 1 Concept Map Data Reduction Table							
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**	**Notes**
C-09-L-01	L	French	F	To value	understand, benefits	to value different activities, foods, (animals?)	
						to value different ways people use their language	
				To communicate			
				To connect		so I can interact with other people in the world	
						without having difficulties understanding	
						to connect different programs, jobs, opportunities	
				To help		to help others to undestand different individuals, translate	
C-09-L-02	L	French	F	understand (how we use language)	which helps you to…	doesn't mean anything in English, but it does in French	
				(gain life) experience	gain wisdom and understanding		
				(experience other) cultures		helps you understand your own situation and how well-off you are	
				(meet and) connect (with people)		can help you accept your own situation	
				gain perspective		can lead you NOT to accept others' hardships as 'just life'	
				help other people		understand people's motives, opinions, life experiences	
				provide opportunities		makes connections that monolinguists would not make	
						open up a new world	
						learn through consequences and real-life situations	
C-09-L-03	L	French	F	tools for	others' future	teaching others, helping others	several sketches, appear to be random
						my future	several one-word labels, reduced out
				spread of culture			
				personal interest		slang used by people my age	
						speaking (new language) regularly	
C-09-L-04	L	French	M	Influences	none	culture	highly creative response, use of imagery, colourful, playful
						history	life depictions…
						future travel	culture
							history/war
							home life
							work
							travel
							food
							Moves straight from Concept to Proposition
C-09-L-05	L	French	F	So is it just a tunnel?	none	No, it's much bigger	Straight from Concept to Proposition
							Tunnel, to 'much larger than a tunnel'
							Map is one large image, minimal words, two characters
							Life depictions…
							tower
							tunnel
							fields
							sky, ocean
							town/village
							pathway
C-09-L-06	L	French	M	impact		by giving more people the opportunity to learn and help others around the world	Moves straight from Concept to Proposition
				inspire	inspire…to help	I want to help people around the world	
				draws influence		factors that influenced decision to learn languages	
						previous success	
						desire to help others	
C-10-L-01	L	French	M	Interest		Enjoyment, learning about other cultures,	Moves straight from Concept to

School C – Phase 1 Concept Map Data Reduction Table							
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**	**Notes**
						countries	Proposition
				Experience		benefit from being even partially bi-lingual	
						be able to survive and cope in a Francophile country	
						communicate with a more diverse range of people	
						apply skills in learning French to other subjects	
						history of enjoying French	
						preferred future…living in Europe	
C-10-L-02	L	French	F	Communication	learn a new culture		Communication is the dominant Concept
					diversifies understanding		
					allows for learners to step back and realise their place in the world	We aren't everything. We are less important than we think we are = humanity	
					understand native tongue on a new level		
					learn new memorisation techniques		
					use a different part of the brain	learning doesn't happen overnight or from just memorising	
						it comes from understanding, not rote learning	
					communicate with others that speak the language		
					sense of belonging	shared bonds	
C-10-L-03	L	French	M	Conceptual	unique thought processes within language	still always something new	
					a lot of repetition	monotonous, but still new content	
					a worldly subject	present ideas in different ways	
						connect with past ideas	
				Value (nominated as a concept)	no obvious relationships, straight to propositions	appreciation of new cultures	
						constant feeling of progress	
						rewarding but occasionally overwhelming	
						opens up more future options	
						appreciation for how communication works	
						understand others and the world better	
						expressing myself in a new language allows me to express myself	
						requirement for a scholarship, career	
						seeing how others live their life is interesting	
						cultural differences are astounding	
C-10-L-04	L	French	F	Culture			CRP framework not obviously apparent
				Travel	Levels	levels of advancement, catering for different levels of assessment	Cocnepts seem clear, yet relationships less so
				Food	Time		Propositions not easily identifiable
				Way of Learning	Conversation	speaking with locals, asking where places are	
C-10-T-01	T	Eng. Studies	F	Thinking	outside the box		Response is graphically creative.
				Creativity			Some sketches which support 'words' used, though
				Reality	share' to make…ideas into reality		sketches don't necessarily add to the words
				Creating	(sharing as part of the process)	Dreams (preferred futures)	
					my creative background	Inspiration	
					prior knowledge	Future	
					experience with STEM	Be the future	
C-10-T-02	T	IST	M	aptitude	hone, broaden their skills		Response mentions numerous IT based labels
				Interest			…they combine to reflect the main proposition of change

School C – Phase 1 Concept Map Data Reduction Table							
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**	**Notes**
				change	make changes	change the world (even if only a little)	
						change someone's life	Change is the dominant proposition of the response.

Table 77 School C - Phase 2 Concept Maps and Analysis Overlays

School C – <u>Phase 2</u> Concept Maps and Analysis Overlays	
	
C-09-L-01	C-09-L-01 overlay
	
C-09-L-02	C-09-L-02 overlay
	
C-09-L-03	C-09-L-03 overlay
	
C-09-L-04	C-09-L-04 overlay

School C – <u>Phase 2</u> Concept Maps and Analysis Overlays	
	
C-09-L-05	C-09-L-05 overlay
	
C-09-L-06	C-09-L-06 overlay
	
C-10-L-01	C-10-L-01 overlay
	
C-10-L-02	C-10-L-02 overlay

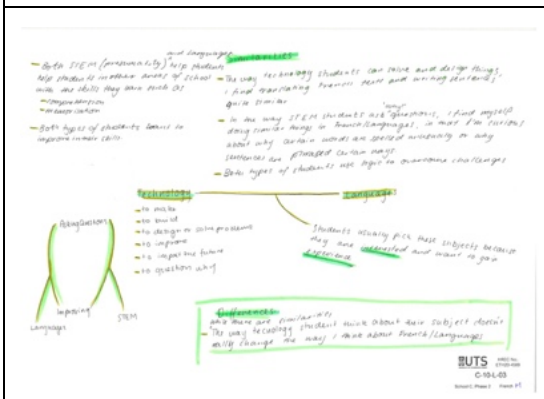
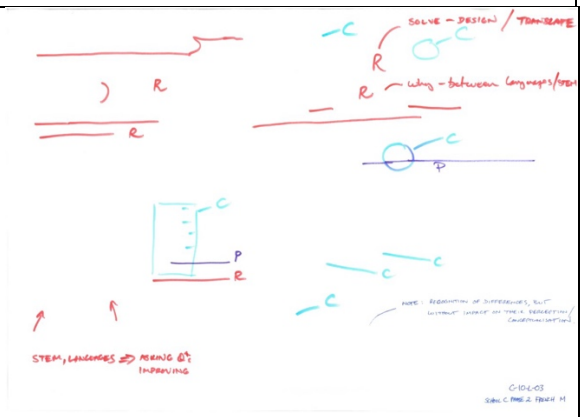
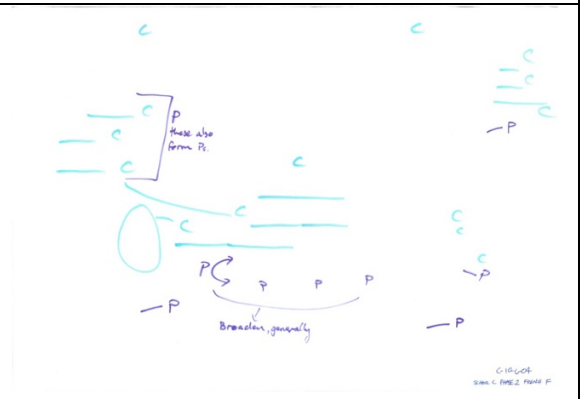
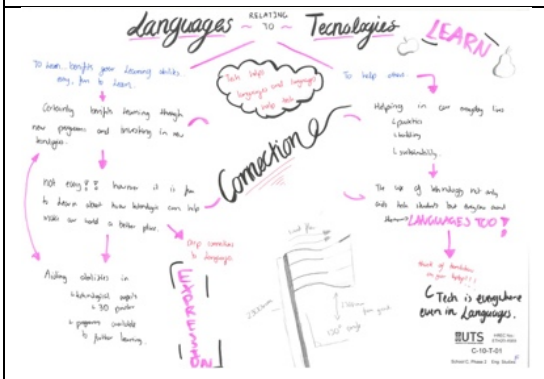
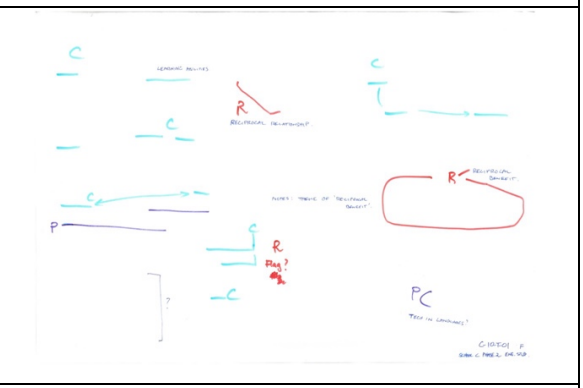
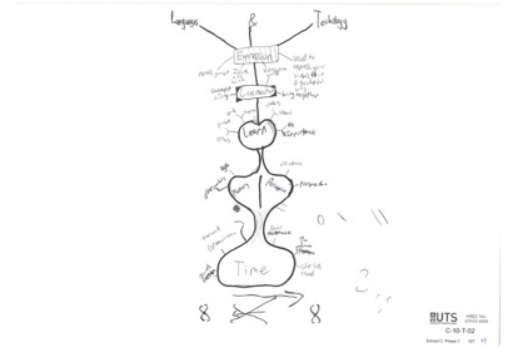
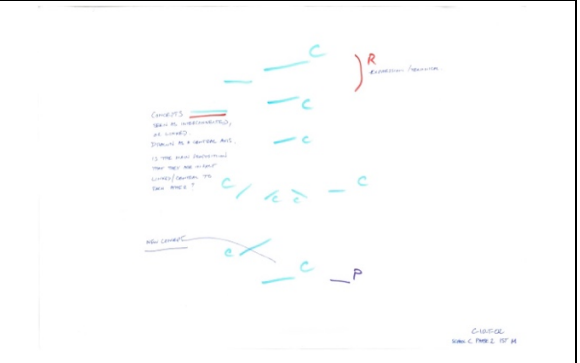
School C – Phase 2 Concept Maps and Analysis Overlays	
	
C-10-L-03	C-10-L-03 overlay
	
C-10-L-04	C-10-L-04 overlay
	
C-10-T-01	C-10-T-01 overlay
	
C-10-T-02	C-10-T-02 overlay

Table 78 School C Phase 2 Concept Map Data Reduction Table

School C Phase 2 Concept Map Data Reduction Table						
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**
C-09-L-01	L	French	F	meeting people		intercultural communication
				encountering cultures		
C-09-L-02	L	French	F	learn new skills	concepts listed join French and technology domains	to improve and make better
				to solve problems	connects with native French / foreign speakers	change the world
				creativity	structured design	bring people together
				use logic		French more practical whereas technology less practical
				make connections		
				future focus		
				to design		
				communication		
C-09-L-03	L	French	M	food	similarities with French / technology	to be creative
				cuisine		to improve
				culture		to learn and make new skills and techniques
				wisdom		use technology
				literacy		to design
				logic		change the world
				lifestyle (change of)		
				communication / expression		
C-09-L-04	L	French	F	creativity	languages as direct links to other domains	Building skills and techniques for the benefit of others.
				future, personal and society	creativity - change	
				helping others	logic/changing logic - change	
				jobs	future - communication	
				travel	travel - culture	
				interests	culture - communication	
				improvements		
				change		
				communication		
				culture		
C-09-L-05	L	French	F	To grow (language)	job / career	job / career
				communicate (language)	improvement	to improve
				travel (language)	skill buiding	to build skills
				learn new perspectives (language)		
				confidence (language)		
				change, the world (technology)		
				creativity (technology)		
				ask (technology)		
				to design (technology)		
				future (technology)		
C-09-L-06	L	French	M	make/build	people	be the future
				skills /techniques	companies	to improve and make better
				learn (new) skills	countries	to make and build with skills and techniques, learn new skills
				improve /make better	languages	

School C Phase 2 Concept Map Data Reduction Table						
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**
				design	products for different language/cultural markets	
				solve problems		
				future		
C-10-L-01	L	French	F	the future	make relationships	perspective is everything
				to make / build	something to connect with	be the future
				new skills	ask why / how	people who speak the language keep it alive
				learn	inclusivity between people / cultures	become more worldly
				know	expressing in different ways	to improve
				express		to be creative
						quick thinking
						make people feel heard
						enhances ways of thinking
C-10-L-02	L	French	M	the future	seeing other culture's systems	seeing other culture's systems lets us learn about our own.
				others	languages and tech connected by a thin wire, some similar ideas but used completely differently	Tech is made to change the world. Language is made to change a life.
				the world	revisit opinions and world view	Tech is somewhat seen in building the ability to communicate.
					communicating in another language makes us reflect on who we are able to be to say it	French won't change the world.
						No greater grand purpose for French.
						Language lets us understand world affairs.
						French won't change the future. It isn't in its nature.
						Tech helps lots physically. Languages can help some personally.
						Languages are the foundation for humanity
						Tech is the bricks we lay to build upon it (humanity).
C-10-L-03	L	French	M	similarities	STEM / Languages...asking questions, improving	Both types of students use logic to overcome challenges.
				solve	to question why	I'm curious about why certain words are spelled unusually or why sentences are phrased certain ways.
				logic	solve - design/translate	Both STEM and languages help students in other areas of school with comprehension and memorisation.
				make, build, design, solve, improve		
				interested		
				experience		
				differences		
C-10-L-04	L	French	F	similarities, new skills, logic, improve		What else can I know?
				differences, to make, solve, be creative		Where can this take me?
				improve skills, memorisation, comprehension, reading/writing		How can I help?
				explore culture		How can I improve?
				learn		Learn new skills.
						Use logic.
						To improve.
						Broaden your horizon.
						Meet new people.
						See more things.
C-10-T-01	T	Eng. Studies	F	Learn	Technology aids languages (translation)	Tech is everywhere, even in languages.
				Learning abilities	Tech helps languages, and languages helps tech.	

School C Phase 2 Concept Map Data Reduction Table						
Participant	**Cat.**	**Subject**	**G**	**Concepts**	**Relationships**	**Propositions**
				investing in new technologies		
				fun to learn		
				Helping others		
				Deep connection to technologies		
				Expression		
C-10-T-02	T	IST	M	Expression	Expression in a technical manner	Life lies ahead.
				Connection		The concepts are linked / share an axis.
				Learn		
				Memory / Perception		
				Time		
				Communication		
				Understanding		

Appendix I – School A, Phase 1 & 2 Follow-up Interviews, Audio transcripts, Data Reduction Tables

This transcript was exported on Mar 01, 2023 - view latest version here.

Researcher:	00:00	Thinking back, can you describe what you drew, when you think about what you drew, with keywords?
Participant 1:	00:09	What's a keyword?
Researcher:	00:11	Oh, a keyword, for example, might be when I think of I-STEM: science. That's a keyword. Or projects or...
Participant 1:	00:23	Practical.
Researcher:	00:24	Practical. Yeah.
Participant 2:	00:26	Creativity.
Participant 3:	00:28	Technology.
Participant 4:	00:30	Understanding.
Participant 5:	00:32	Innovation.
Participant 2:	00:34	Maths. Skills.
Researcher:	00:37	What kind of skills?
Participant 2:	00:38	I-STEM skills. I wrote down a whole bunch of different ones, like 3D printing, and tech drawings, and drawings and stuff like that.
Researcher:	00:50	Are they the kinds of skills you were expecting?
Participant 2:	00:54	Yes, sort of. But I was also expecting to learn lots more basic stuff, like how to do code, and that sort of thing.
Participant 1:	01:06	Yeah. The basics of...
Participant 2:	01:08	Basics. And other stuff as well, like electronics and things and how stuff works, really. I was expecting to have class time. Like sessions when the teacher would sit down and teach us about a certain thing, that would help us with that project. But that didn't really happen.
Researcher:	01:29	When you say it didn't really happen, is that because it was more of a student-led experience?
Participant 3:	01:34	It's because the teacher didn't really engage with the students a lot. [crosstalk 00:01:40]

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Participant 4:	01:39	I reckon if you saw him after, if you went and asked the teacher without him teaching, he'd tell you. But he doesn't sit down in class to do it, just if you ask.
Researcher:	01:50	So when you think about your expectations or when you think about those key ideas, as in keywords, key ideas, what were the things that you found that were difficult to represent graphically or to draw? Like the stuff that we've been talking about now?
Participant 5:	02:09	I suppose the teachers not always having the right answer, wasn't something that you could really draw.
Researcher:	02:15	When you said that the teacher didn't have the right answer, is that because they would throw the problem back at you? Or is that because the expectation was that it was student centered, you're supposed to go and find out?
Participant 5:	02:25	I think it's a little bit of both.
Participant 3:	02:27	Yeah. I would say yes, because every time we asked him what to do, he said, "Go look it up."
Participant 4:	02:32	That's the old teacher.
Participant 2:	02:34	That's the old teacher. The new one is good. [crosstalk 00:02:39]
	02:35	Yeah.
Participant 5:	02:35	Yeah.
Participant 1:	02:38	But it's still like you have to go and ask. There haven't really been that many teacher to class session things.
Participant 4:	02:48	Yeah.
Participant 5:	02:48	There's not many whole theory sessions. [crosstalk 00:02:53].
Participant 1:	02:51	If you want to learn something, you have to go and ask the teacher.
Participant 4:	02:57	Yeah, but you learn by doing stuff.
Participant 1:	02:59	Yeah. So it's a very different environment to a normal classroom.
Participant 4:	03:04	Yes.

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Researcher:	03:05	So when you say there weren't specific theory lessons, is that something that you were expecting?
Participant 2:	03:11	Yeah, but I enjoyed the learning by doing the things a lot more than sitting down in the classroom and just writing stuff down and filling out worksheets.
Researcher:	03:21	Because that's interesting, because I teach or I have been teaching design and technology and industrial technology for a couple of decades now. And the thing that I always find students reacting to is not theory, can't we do [prac 00:00:30:16], whereas here I'm hearing something that is maybe not quite so well-defined. I'm getting the impression that maybe you would've liked to have a little bit of more direct understanding. [crosstalk 00:03:49]
Participant 1:	03:48	Yeah, it would have been good, because it would have helped us a lot with our projects.
Participant 5:	03:50	Yeah. So everyone's able to do their own thing and learn by doing, but then also the teacher can use all of those basic skills that you can build up to do your project better.
Participant 1:	04:03	Yeah. I reckon that the teachers should lead the kids in the right direction rather than holding their hand there. They should give them a direction to go on and give them basic skills to build on them, so they can get where they need to be.
Researcher:	04:20	Given the fact that it's called I-STEM and that effectively means science, technology, engineering and maths. What did you think that the primary areas of focus might be?
Participant 2:	04:33	Engineering.
Participant 1:	04:33	Engineering and technology.
Participant 3:	04:36	Yeah technology, engineering.
Researcher:	04:37	And what do you mean by engineering? What kind of idea did you have in your head, when we talk about engineering?
Participant 3:	04:45	I suppose, mechatronics type engineering, so it'd be interaction between mechanical engineering and electrical engineering.
Participant 4:	04:56	Yeah. I envisioned an engineering more of a physical thing. Whereas maths and science you do a worksheet or you learn something and write in your book. Whereas with engineering,

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		it's more like the teacher will tell you how to make something and you make something physical.
Participant 2:	05:10	I would say engineering, when I thought of it, I thought it would be more practical for the most part, but I've thought it'll be a bit more theory as well, because I thought there was going to be loads of worksheets that we have to do, because I like writing instead of doing, because, yeah. It's much easier for me. Yeah.
Researcher:	05:32	So when you say worksheets, for example, if we can just pull out this very simple example, there's a span that's 10 meters wide and I need to make a bridge. I've got these materials. What load can it carry? More like physics? Is that what we're talking about?
Participant 2:	05:49	Yeah. Adding the science and maths part into it.
Researcher:	05:52	Right. Were you expecting to learn specific maths and science concepts or just the science of stuff?
Participant 2:	06:01	So I was thinking we're going to learn more some science stuff and some maths. So how to calculate the weight on a bridge and how the stress is. [inaudible 00:06:16] And for science, have the physics of how the thing would work, will it fall or does it have enough pressure to push itself itself up? And yeah.
Participant 1:	06:27	Yeah. We never really did any of that sort of learning in I-STEM, it's mostly just building stuff.
Participant 2:	06:35	The science and the maths is integrated into it and it's not a very strong feature of the course.
Researcher:	06:43	So when you say integrated, would you come to a class and they say, right, here's a mathematical concept that we need to understand for this project and let's work that out? Or was it just we need to do some calculations?
Participant 2:	06:54	No. In the project that you do, the science and the maths is included inside of it, as well. Basic skills like finding angles and stuff to make the shape of what you want, like in 3D design and stuff.
Researcher:	07:08	Okay. Were there any areas that came up that you didn't expect?
Participant 3:	07:13	We did talk about batteries one time.

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Participant 4:	07:15	Oh, yeah.
Participant 3:	07:15	I didn't think we'd learn about batteries.
Participant 4:	07:17	One time we had...
Participant 1:	07:17	A substitute.
Participant 4:	07:19	Yeah. I suppose [inaudible 00:07:22]. One time we had a teacher, a substitute come in, and they just taught us about batteries and voltage or wattage something. That was the only theory session we ever had.
Participant 1:	07:30	It was a great session.
Participant 4:	07:32	And so, yeah.
Researcher:	07:33	Let's talk about the rationale then. Why do it? What do you think the rationale is for the subject?
Participant 2:	07:39	It's enjoyable.
Participant 5:	07:39	Yeah. And you get major works to do.
Participant 1:	07:42	You do hone your skills.
Participant 5:	07:42	Well, yeah.
Participant 3:	07:46	I was thinking of doing it because my future job career choice in the future, so I was doing... Because it's what I want to do. It needs a genuine knowledge of pretty much everything that it is, so Navy, if I wanted to join the Navy, I had to know everything on the ship before I can become an officer on it or something.
Researcher:	08:06	Okay.
Participant 1:	08:07	I think it's a good taste for anybody who wants to do it in there, is looking at doing that for their future careers and things, to see if they find that kind of thing enjoyable, because there's not much. You don't get to understand. There isn't much teaching the theory behind all the engineering and stuff, but you do get to make the projects and things and similar projects to what you would do, probably, outside of school. And there's a range of different projects and things that you do. So if you enjoy it, then you might want to go to uni and then you would be taught the theory and stuff behind it.

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Participant 5:	08:53	I studied it because I was considering it as a job opportunity, kind of thing.
Participant 4:	08:59	I did it because there's no other class at school where I can specifically do stuff that I enjoy. I like computers and stuff, and I build them in my spare time, but there's no other class that can let you do that for a major work or help you understand why certain bits fit together, but engineering sort of fit that. And I guess that's what I did.
Researcher:	09:25	So we're starting to talk about the wider scope of why you might do this. So we've mentioned career, job, personal interest, getting to uni. Where do you think this might lead in terms of a wider scope, thinking beyond those things? Does it have a global impact?
Participant 3:	09:42	Well, right now it would have a global impact because Australia is lacking people who want to be an engineer, because yeah, reasons. So they're trying to get us to learn engineering, so they can get more people into the roles and for the future.
Participant 5:	10:01	Yeah. So I suppose engineering's really good... Lots of engineers in your working population is really good, because each of those people bring a lot of, I suppose, something... One engineer can do, can bring a lot of jobs for a lot of people, which can be very good. Especially, with lots of people losing their jobs at the moment with COVID.
Researcher:	10:31	Do you think that culture plays a role? We're thinking globally now. We're thinking, perhaps, beyond our shores. You've mentioned the Navy. That means, by definition, we're moving beyond our shores. Do you think that if there is a wider impact and a global impact, do you think that culture plays a role with that?
Participant 2:	10:47	Yeah, I think so. I think people probably subconsciously, the culture would play a role in how they think about engineering and what they want to do as a job. I think that probably different cultures would have different, I suppose, mindsets on working. And therefore, different mindsets on who should do what jobs kind of thing.
Participant 3:	11:13	Yeah. So many cultures around the world and countries have been doing engineering, so for a long time, and have been progressing further than any other country has. And mostly African countries now, because they were British and European owned. And now that they're left on their own, their

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		engineering might not be as advanced as other countries, like most of the European countries, because they were the first ones to do [inaudible 00:11:41] engineering and the Americas.
Participant 4:	11:43	And modern engineering.
Participant 3:	11:44	Modern engineering. Yeah.
Researcher:	11:46	Have you ever done projects here in the course that you've done, which have had a global focus, where the focus has been in need to design a solution to this particular problem for a context that is outside of your culture?
Participant 5:	12:00	Oh, in I-STEM, I think they basically designed some solar powered lights to send to... Who was it?
Participant 2:	12:07	Malawi.
Participant 5:	12:08	Malawi? Just so people could have a [inaudible 00:12:16], so they were able to live, not just when there was sunlight and so that they were... Because if people are able to have a productive life when it's dark, then they can get a lot more stuff done in a day and progress further and that can help a lot of countries out of a poverty situation.
Researcher:	12:35	Do you think that that is important to address in this subject?
Participant 5:	12:38	Yeah.
Participant 2:	12:39	Yeah.
Researcher:	12:39	What sort of interaction do you think you might have to have with other cultures? For example, with that example that you just gave. Is it just a matter of designing something that we think works for them and then handing it over to them? Does it stop there? Or what happens after that?
Participant 3:	12:54	I would say that countries should do technology alliances so they can share their technology and their ideas and their resources to help other countries that are third world to build up so they don't get disease a lot, because of their healthcare system and how other countries have really good healthcare, some countries don't.
	13:20	Because belong... Everyone deserves to be on the same level. Everyone deserves their right to have a life and healthcare that can support them.

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Researcher:	13:30	Given the fact that not all cultures speak English, how do we cross that barrier?
Participant 3:	13:34	Well, I suppose...
Participant 4:	13:36	Translators.
Participant 5:	13:37	Yeah [crosstalk 00:13:38] that would be translators. But also, I suppose, if you're not able to get a translator, I suppose, being able to have empathy for that culture and look at it, and people trying their best to look at it from the other person's perspective, people in that cultural perspective, so that they can make the best solution to their issue, even without knowing the language.
	14:09	But getting to know the situation really well, so that they can design a product really well. And speaking to people who have maybe designed products before or been in situations like that, so that they know what issues they face and what will actually help them.
Researcher:	14:27	What's one of the best ways do you think to get the perspective of people from other cultures?
Participant 5:	14:32	I suppose, talking to people.
Participant 3:	14:34	Know their religion, know them, their people, and what they believe in.
Participant 4:	14:40	Just spend time with them, really.
Participant 3:	14:41	Yeah.
Participant 5:	14:42	Yeah. Spending time with them. Speaking to them.
Researcher:	14:47	Let's just push the boat out here a little bit, if you know what I mean by that, and say, all right, if we're going to get to know them and get to spend time with them, would you consider learning their language?
Participant 3:	14:59	Yeah, I think that's...
Participant 4:	14:59	Yeah.
Participant 3:	14:59	Yeah. I think that'd be a...
Participant 5:	15:02	I think we need better language courses in Australia.

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Researcher:	15:06	Yeah? What is that? [crosstalk 00:15:07]
Participant 4:	15:06	Well, in a lot of European countries [crosstalk 00:15:12].
Participant 1:	15:10	They would learn two languages.
Participant 3:	15:13	[crosstalk 00:15:11] Compulsory one, too.
Participant 4:	15:13	Yeah.
Participant 5:	15:14	Yeah. I think that's very [crosstalk 00:15:16] benefited people, if you've got a population that can speak a wide array of languages, that then makes your country a more attractive prospect for people who don't know how to speak English, because then there's a country that there's going to be people that will speak your native language, even if you don't. Which means that they are going to have an easier time. For example, if they want to migrate here because their own country isn't what they want it to be, or if they were just coming for tourism, I think that would bring other people into Australia.
Participant 1:	15:53	I think we need it, as well. Especially, with all the connectivity that we have these days. There's a big branch of people that we're closed off to, not only on a social's sort of idea, but imagine the amount of work that could be done if engineers from Australia were able to properly communicate with engineers from some other country who speaks a different language. And we just don't have that at the moment, I guess.
Participant 4:	16:19	Yeah.
Researcher:	16:20	Would you like that?
Participant 1:	16:21	Yeah, that'd be good.
Researcher:	16:22	Would you do a language alongside I-STEM as an example of how we might address that?
Participant 4:	16:28	Yeah.
Participant 1:	16:28	Yeah. I think that'd be good, but I also think that doing languages from early childhood education, so even incorporating different languages into preschools, because it's a lot easier. Younger children have a lot more neuroplasticity, so even though teenagers, they have more neuroplasticity, it's a lot harder for them to learn a language than if they were a five-

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year-old trying to learn the language. And I think teaching people different languages from a young age.

Participant 2: 17:02 If there was more language at school, I'll certainly do one, but since our school only does one language, French, because yeah, I don't know.

Participant 3: 17:10 I think we've got two French. [crosstalk 00:17:14].

Participant 2: 17:11 We've got French teachers that actually teach French. The thing is, most people don't want to learn French, but they want to learn other languages, because French is not really a big, big language around the world right now.

Participant 4: 17:24 I think Mandarin would be [crosstalk 00:17:28].

Participant 2: 17:25 Mandarin or Chinese simplified or German or Spanish or Portuguese. But we say, they're of the biggest languages around, because most of South America speaks Portuguese or Spanish. Most of European countries do not speak English, but some do for their second language. And most Asian countries don't speak English, as well. English is not a really major language when you come to think of it, because of all the other different countries around the world.

Participant 1: 18:00 It's definitely the biggest language, but there are more secondary, there are more people who speak second languages, as well. Even though English is the most widely spoken, generally, it's not the first language. It's mostly the secondary or third. It's the international standard.

Participant 4: 18:20 Yeah. But as global superpowers shift more from America to China...

Participant 1: 18:27 And India.

Participant 4: 18:29 Yeah, and India that is changing. So I suppose, yeah. So it's good to be pliable to that.

Researcher: 18:38 I once heard it said, not all knowledge is created in English.

Participant 2: 18:43 Yeah.

Researcher: 18:43 What do you make of that?

Participant 2: 18:44 Well, I think, back in the day, everyone put their knowledge in their own languages. So the Chinese put all their gunpowder,

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		guns and stuff like that, that was not translated to English. It was either translated into Latin, because the only people that... The only language that the Chinese spoke to Europeans, was in Latin, because the Romans found the Chinese first and then they only spoke Latin, so the Chinese learned Latin to stay back. And so many countries don't really know what they're talking about.
	19:18	Like Germany, when they made rockets and stuff, that was not generally English. And so no one knew what that was until they got people to translate it. And other countries then stole it. UK, when they made factories in English, so not many other countries could read it, and yeah.
Participant 4:	19:41	Yeah. So I suppose, when you got, especially in Australia with a relatively small population, when you've got a small population that only really most of them only really speak one language, you've basically closed yourself off from a good chunk of the world's knowledge and you're just going to be focusing on the main English speaking nations.
	20:11	You're not going to get all that knowledge from India. You're not going to get all that knowledge from China. You're not going to get all that knowledge from anywhere else in the world. You're just going to get it from America, the UK, and then a couple of other European countries.
Researcher:	20:28	There are five of you sitting here. Let's take a quick poll. If you could choose to learn a language, which one would it be?
Participant 4:	20:34	German.
Participant 5:	20:35	Maltese.
Researcher:	20:36	Maltese.
Participant 5:	20:36	Yeah. My family's from Malta.
Researcher:	20:39	Right. Okay. So you have a strong sense of cultural history within your family that you'd like to-
Participant 5:	20:45	Not, I suppose I wouldn't say strong, but just interested family-wise.
Researcher:	20:51	Yeah. Great.
Participant 5:	20:52	Yeah.

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Researcher:	20:52	So, German, Maltese...
Participant 3:	20:55	I don't know. Chinese, probably. Mandarin.
Participant 4:	20:55	Chinese.
Researcher:	20:58	Chinese?
Participant 2:	20:58	Chinese or Japanese.
Researcher:	21:01	Okay. So that's an interesting mix. So coming back to I-STEM, where do you think the subject that you're doing now is perhaps deficient and what would you like to see more of?
Participant 1:	21:14	I would like to see more students to class learning.
Researcher:	21:17	Sorry?
Participant 2:	21:18	Student... No. Teacher to class learning.
Researcher:	21:20	So you'd like to see more direct instruction. Is that how you'd describe it?
Participant 2:	21:24	Yeah. And the teacher's teaching the class about that topic. Standing at the front and...
Participant 3:	21:30	So not as loose at it as it currently is, so.
Researcher:	21:34	Tighten up a bit.
Participant 3:	21:35	Yeah.
Participant 5:	21:36	Yeah, because I feel like, at the moment, sometimes it feels to be disorderly and just there's no structure at all.
Participant 3:	21:44	Yes.
Participant 5:	21:44	But I think with just a little bit more guidance, I think that it would make it a whole lot better. Because I think a lot of people that I've spoken to who aren't particularly gifted in engineering and stuff who are doing the course, they often feel lost to what they're supposed to be doing.
Researcher:	22:05	Mm-hmm (affirmative)
Participant 1:	22:06	So it's a lot easier for people who have background knowledge. A couple of our mates-

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Participant 5:	22:11	Yeah, because people-
Participant 1:	22:11	A few of them already are really good at technology and engineering, electronics and mechatronics and things, 3D printing and stuff, already know how to do all that stuff. And often they're the ones that are teaching everybody else who's lost or they don't have any background knowledge.
Participant 3:	22:30	I'm just saying, it's really loose. I'm just saying it's a bit too loose in our classes, because some people, when they're trying to move forward, they go back instead. So some people are actually making their way to the finished goal. And some people are just not making it. They're just not. They don't know what to do. They don't know which path to take. And if they have someone to guide them, they'll make it much easier for them to reach the goal.
Participant 4:	22:54	I think it's hard to say for my teacher right now, because the teacher we had before was pretty rubbish. He didn't do anything for us. He pretty much left it to us to do nothing. He wasn't there half the time. He was ditching students. [Crosstalk 00:23:11].
Participant 1:	23:09	He told us some things.
Participant 4:	23:10	Yeah, he told us some things, but not what you would expect.
Participant 2:	23:13	Like games, half the time.
Participant 4:	23:14	But our new teacher, it's hard because we've meant to be doing our major works this year, and on top of all of the COVID and all that stuff, he's had to pick up all the remains of what the teacher before left. So it's hard for him to come into a new school in a bad situation and do that. So I think he's doing a pretty good job, but I think more theory lessons, like whole class theory lessons, not individual, would be good.
Participant 1:	23:42	And that would've been good in year nine, if we had a new [inaudible 00:00:23:48], we probably wouldn't need to worry about this year.
Participant 5:	23:49	Yeah. So he spent half the time, half a year working on lamps.
Participant 3:	23:53	Yeah.
Participant 5:	23:54	We spent four terms working on drones that only-

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Participant 3:	23:58	Well, COVID interrupted it-
Participant 2:	24:00	Yeah. And we didn't make any drones by then, but some people did start. We mostly just did drone simulations on the computers and that's pretty much it. And we started our major works proposals, just because our old teacher did not know what to do with us.
Participant 4:	24:15	Yeah.
Participant 2:	24:15	And so we did three terms on major work proposals, and then we actually started that major works.
Participant 4:	24:21	I think it's been pretty good. I've enjoyed it. [crosstalk 00:24:25] As disjointed as it has been, I reckon it's better than Foodtech.
Researcher:	24:28	Well, it is a little bit surprising to me given my background to hear young guys like you say are, more theory, structured lessons, direct instruction. Really?
Participant 1:	24:40	You should see the structure of our lessons. It's just come in and just [inaudible 00:24:50]. It's very easy to bludge.
Participant 2:	24:49	Yeah.
Participant 1:	24:50	Very, very easy to bludge.
Participant 2:	24:52	Many people in our class think it's easy to get away with not doing anything, not going to name names because I don't want to.
Participant 4:	24:58	We've got our major works due next term with two...
Participant 3:	25:01	Three school weeks. Three school weeks.
Participant 4:	25:04	Yeah. Some people still haven't ordered their password.
Participant 3:	25:06	Some people have even thought of what they're doing.
Participant 5:	25:08	Yeah.
Researcher:	25:13	Who would choose to do a language here, if you had a good set of choices [inaudible 00:25:24]?
Participant 5:	25:16	Yep.
Participant 2:	25:17	Yep.

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Participant 4:	25:18	Probably.
Researcher:	25:20	Three or four out of five?
Participant 4:	25:22	Four out of five.
Researcher:	25:25	If you had a set of languages that you could choose from, let's say a European language an Asian language, and one other, maybe a second one of either of those two. Let's say you had three to choose from.
Participant 4:	25:36	Middle Eastern.
Researcher:	25:37	[Crosstalk 00:25:37] Middle Eastern? Yeah, sure. Why not? Or an African language. Why not?
Participant 5:	25:40	[crosstalk 00:25:41] Indigenous to Australia, would be interesting?
Participant 3:	25:43	Oh, God.
Researcher:	25:43	Really?
Participant 5:	25:44	That'd be interesting. I don't know. I think I'd choose one above my electives already, but I'd be very happy to do it.
Participant 2:	25:50	If, it was integrated.
Participant 5:	25:52	Yeah. [crosstalk 00:25:57], but if it was I-STEM L...
Researcher:	25:55	That's fascinating. Integrated. Sorry. I'll come back to you. Yeah, go.
Participant 5:	25:59	French [inaudible 00:26:01] in seven. But I just dropped it. It didn't even do any... In here I didn't have electives, but we didn't do French either. IF we had language as a compulsory subject and we can choose a language in year seven, year eight, year nine and year 10, I'd be very happy to do that.
Researcher:	26:19	Wow.
Participant 2:	26:19	Yeah. And also because, many other schools get language choices and we don't. We get one choice throughout every single time, because unqualified teachers, and so more options would have been great. And I would have definitely chosen that over one of my electives. And integrated would be also very good.

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Researcher:	26:39	So integrated, yes? And sorry, because I want to come back to your comment about I-STEM L. So talk me through that. Do we have a couple of minutes? Can you talk me through that?
Participant 5:	26:51	Yes. I-STEM L. It's where it's I-STEM, so it's science, technology, engineering, maths, but then adds language.
Researcher:	27:01	So would you expect to come to the class and learn it in another language or just or just kind of both?
Participant 5:	27:07	Have [inaudible 00:27:08] sessions. And then if you progressed far enough in the language he could teach how a motor is working in Chinese or something. I don't know. [crosstalk 00:27:19]
Researcher:	27:19	Or perhaps you could translate instruction manuals that were written in English, but come from China and have got language problems, because that's often the case.
Participant 1:	27:29	That's helpful, because a lot of the parts we get are straight from China and we don't understand any of the words.
Participant 2:	27:37	Yeah. I remember one of my projects, I was using a special type of switch and in the box it came from, all the instructions of how to solder it and wire it were all written in Chinese. And I ended up spending an entire double session, just trying to figure out how to work this switch.
Researcher:	27:55	So let me just get this straight. You would want to have some integration of the language. Not a hardcore, you walk through the door and everything's in another language, but you would be happy to have another language integrated as part of what you had to learn. Would you be happy to be assessed on it as well?
Participant 4:	28:12	Yeah, definitely.
Participant 3:	28:13	Yeah, definitely.
Researcher:	28:14	Yep. Okay. So like a STEM class where, let's say you had to do an assignment, and I'm just thinking purely conceptually here, let's say, had to do an assignment and how things are weighted. Like, this bit's worth that much and that bit's worth that much. Let's say, 20% of the assignment was related to how well you represented this theory or this text in another language, for example.

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Participant 3:	28:35	Yeah.
Researcher:	28:36	You'd be okay with that?
Participant 4:	28:37	Presented a different way. Like, Oh-
Participant 5:	28:40	In front of the class or something.
Participant 4:	28:41	Yeah. No, it's like, this product has to be rolled out in this country. How would you present that to-
Researcher:	28:50	Oh, so an application?
Participant 4:	28:51	Yeah. So you go, how would you explain what it does and do it to somebody who doesn't understand English.
Researcher:	28:58	Okay.
Participant 2:	29:01	Probably make your own instruction book that's English and another language.
Researcher:	29:06	Like when you get your digital camera and you open it up and the instruction manual is really thick, because it's got 20 languages in it. [crosstalk 00:29:14] So that kind of thing.
Participant 5:	29:14	Yeah.
Participant 4:	29:14	Yeah.
Participant 2:	29:14	Yeah.
Participant 1:	29:15	Yeah. I think the reason that we didn't... We had no French in year seven, wasn't because the French teacher was dedicated to French. She taught other things, as well. So it was an add on, and I don't think the attention of the school was to get her to teach French specifically. It was just there after. [crosstalk 00:29:42].
	29:34	So that's the reason that it was so sporadic. Because it was in year seven you got French and then you didn't get the opportunity to do it again until...
Participant 2:	29:44	Electives.
Participant 1:	29:44	[Crosstalk 00:29:45] year nine and then if no one chose it, year 11.

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Participant 5:	29:50	Yeah. And it was like everyone knew that it was going to end at the end of the year and it didn't feel very polished. [crosstalk 00:30:05]
Participant 1:	30:04	I enjoyed French. I finished year seven thinking that I wasn't the best, but I enjoyed it. It was good to learn a different language, but by the end of the year, I was completely comfortable not remembering any of the French.

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Researcher:	00:00	So we've got five I-STEM students in this class. We've got four from year 10 and one from year nine, is that correct? So you are year nine and the rest are year 10.
Participant 2:	00:09	Yeah.
Researcher:	00:09	Okay. So you've been presented with different value propositions or different propositions from a group of students in a different location who do languages. Those propositions broadly cover the concepts. If I can break them down to say one or two words, better or true understanding learning or benefits of learning or benefit to learning. Improvement, as in memory and intelligence. Benefit in terms of the brain as in both sides of the brain. And the concept of connection as in allowing to connect. And I've asked you to re-conceptualize your subjects. Now, the thing I'm interested in is, does this make any difference to you? Does this mean anything to you or do you just go, no I'm just the same? I'll just throw it open.
Participant 2:	01:03	I think most of them mean a bit, so [inaudible 00:01:07] the memory skills and intelligence bit. But I think the other ones do because they relate a bit more to humanitarian side of engineering. So maybe, yeah, so humanitarian, so stuff like engineers without borders and stuff. Engineers and different humanitarian issues that can be fixed with engineering and engineering mindset. I suppose there's optimizing manufacturing things to get products cheaper but higher quality that last longer for people, especially for people who can't afford to spend $20 here and there every single time something breaks. Yeah.
Participant 3:	02:01	I think the connection is really cool because there's a lot more I feel in technology today than just getting the product to be as efficient as possible. It's a lot of stuff with tech companies, you see it with big social media firms and Apple and that, they'll do a lot to do with people rather than just the product because I mean people are buying it.
Researcher:	02:30	So are you, let me see if I can get where you're coming from. Instead of just focusing on making, say the mobile phone faster and taking better pictures and say lighter or with a longer battery life, what we're talking about or what you are suggesting perhaps is making the technology more human somehow.
Participant 3:	02:52	Yeah.

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Researcher:	02:52	Or applicable to humans.
Participant 3:	02:54	I feel like especially Apple, you can see that they've put a lot of effort in making their operating system and their actual hardware seem a lot more alive and not that cold as you see in old computers where it was literally just there with one purpose and that was to do what you told them. Whereas today it seems that they're putting a lot of effort into making it a lot more user friendly and get that connection from the user.
Participant 2:	03:25	Yeah, especially from their design languages, simplistic design language, it's something that's quite approachable. I suppose there's a lot of design and marketing psychology behind that. So making their products approachable and people enjoy using them because they use high quality materials. But even though Apple's a premium brand, they're still, you get a really nice quality computer if you buy a MacBook. It's got nice quality materials. Whereas things in that same price range, they might perform 5% better but their materials are less nice. They might use plastic, they might use a softer metal or they really focus on the fit and finish and the feel of their products, which is something that differentiates them a lot.
Researcher:	04:28	Do you think you should be applying these things to your I-STEM projects? Should this kind of mentality influence what you do in the classroom?
Participant 2:	04:34	Yeah, I think we should like I mentioned like a reflection on ISO and what we could get. And I really thought that we ought to get, I suppose it's expensive, ought to get some milling machines so people could get some high quality metals and mill them to create a really high quality, really precise fit for their product. So it seems like a seamless product that could be released to market immediately. I think that would really set people up to actually designing products in the future if that's what they want to do.
Participant 3:	05:14	Can I talk about a personal thing?
Researcher:	05:18	Sure.
Participant 3:	05:18	So for my major work, I built a [inaudible 00:05:20] machine and I spent a lot of time trying to work out what the comfortable height for the buttons and the keyboards and where in the control panel the buttons and the joysticks were to try and make it nice to use. I could have just put it anywhere but I asked heaps of people and had the tape measure next to them where

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it felt nice if they just had buttons and joysticks. So I could have made it and I could have used less space and it could have been a lot more efficient. But in doing that it made it a lot nicer to use because it was more comfortable.

Researcher: 05:54 What do you think that you were really trying to achieve there by doing those things for that mystical person who might use your product? What was the motivation for you to do it?

Participant 3: 06:09 I wanted to make it nice to use because effectively it is just a piece of furniture and I wanted to make it comfortable to use like you would any piece of furniture.

Researcher: 06:20 And so you were trying to, what were you trying to gain from the other person or from the user? What was that bridge you were trying to cross there?

Participant 3: 06:33 I guess I was just trying to make it easier to use, more enjoyable for them. So enjoyment.

Participant 2: 06:41 Yeah, like some people actually want to go down and sit at and they want to actually use it better. They're going to get tired from using it. They're going to be like, we're going to be able to use it for longer. They actually get able to enjoy what they've purchased if they do purchase something.

Researcher: 06:57 What about you guys? Did any of these things mean anything to you in terms of how you consider what you've done this year?

Participant 4: 07:08 Well I believe most technology has been getting off track. So back in yonks ago, when they had those chunky computers and how they're like, oh the new thing, these are really good. And now here they're like, oh this has got the newest specs but it might not look nice but it's got the best specs. You can use this for best specs. But I feel like they should focus more on user comfort like they've been saying before. And how the user is the most important part of the company because without the users, the company can't continue to go because they're not getting their stable income.

07:47 But I don't think companies should focus on their mass in better specs. I feel like they should focus on user comfort because if every company just keeps focusing on the better, they risk quantity over quality. They're getting rid of their quality and just pumping up their quantity. But if they focus on stabilizing that, they'll make it 10 times further.

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Researcher:	08:13	So let me see if I can get a better understanding of where you're going with that. And I'll put this question to all five of you. We'll play fill in the blanks. To produce a better product, the company must blank the user. What one single word would you put in there?
Participant 2:	08:31	Respect.
Participant 3:	08:33	Understand.
Participant 4:	08:35	Honor.
Participant 5:	08:39	That's all good. They were good? Yep.
Participant 6:	08:43	Interest.
Researcher:	08:45	All right. Take those words, those ideas. Should they, could they, how would they be better incorporated into the projects that you are doing? Because that's the direction in which you are heading.
Participant 2:	09:00	I suppose maybe require some sort of, I'm doing [inaudible 00:09:07] culture next year, requires some sort of interactive elements where you go out and do market research. So you go out and interact with your target audience and say, look, I want this, I want to design this, what would you use it for and what would you like to see included in that? And then show in the final report show how you've done that to teach people how to cater to people.
Participant 4:	09:39	Yeah, I think that's a good point actually. Just with our I-STEM projects that we've done over the past two years when maybe except for major work, all of our projects have been, like we were told to do them. They were all, we knew what they were about. They were laid out for us before the course started and they were set, there was already marketing criteria. And there weren't really any aspects that involved human interaction or anything or getting involved with culture or anything like that.
	10:18	We did a lot of kind of projects where it was just like, oh make an LED lamp. And it's like okay great, well we make that. There's no involvement with culture or community and something. It'd be nice if maybe not as much free choice with the projects that we do, but just making the projects a little bit more involved with connecting with other people and things. I know that they, I'm not sure if it was your class that did it but Mr. Bonzo or wait, can I say that?

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Researcher:	10:55	Yeah, I'll edit that out.
Participant 4:	10:57	Sick. Mr. So-and-so's class, they 3D printed a whole bunch of.
Participant 3:	11:05	Lights.
Participant 4:	11:05	Light cases and then sent them away to an actual community that actually needed them. And that was a project that involved other people and had an actual need and connected us. I feel like that's being a bit more beneficial. I think I'd also enjoy project a little bit more like that because I feel like there's actually a need for it, doing something.
Participant 2:	11:27	Yeah. You feel like you're doing something. Yeah, I think feeling like you're doing something to help people would make students take more consideration in what they do in their projects. So that they're not just making a project, they're designing something for someone. Yeah.
Researcher:	11:56	And do you think the absence of that in what you've been doing over the last year or two is just what it is? Or is it a weakness? Or how would you describe it?
Participant 4:	12:06	It's a weakness I think.
	12:07	Don't have much. A lot of the projects are, they're not boring, they're interesting. It's limited in the skills that you actually learn.
Participant 2:	12:19	Yeah, there's only so many [inaudible 00:12:21].
Participant 4:	12:21	Yeah. And because of, if there's going to be a project that doesn't really have an impact in the world or anything or leads to you having an impact, then there really needs to be a lot more building skills based. But I think instead a lot of the projects were just like, you're going to learn some skills, but really this project is fairly straightforward and it doesn't have an impact.
Participant 3:	12:49	Yeah. Just reiteration of previously learned skills in a slightly different way.
Participant 4:	12:54	Yeah. So pretty much all our tasks have been, oh you're going to make a lamp, solar, stick, print something, finished. Oh you're got to make a drone, put it together, code it.

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Participant 2:	13:11	Yeah. I suppose say for example the drone thing, all we did was build a drone that came in a package and then we learned how to fly it.
Participant 4:	13:21	We didn't actually fly it.
Participant 2:	13:23	Yeah. I mean you would have, there were complications with that, but we just learned how to fly it and build it. It would've been good if there was like we could take those skills and it was like, I don't know, build your own drone or something, how could you build something that will benefit others or what is a simple purpose?
Participant 4:	13:40	Yeah, it's like a drone that takes water or something to an outback community instead of a drone for recreational purposes.
Researcher:	13:47	So how about I just throw this at you, I'm mindful of the time, but I'm going to take a few more minutes if that's okay. How about I gave this to you as a brief. Here's a problem. I want you to produce a solution to this problem that demonstrates to me that you understand the problem.
Participant 4:	14:08	Yeah.
Participant 2:	14:09	Yeah. I think-
Researcher:	14:09	Would make a difference to you?
Participant 2:	14:11	I think that'd be really good because I think that people would get involved in it. There wouldn't be as much slacking off, I don't think because people, they'd use their brains more as [inaudible 00:14:25] contact to these focus questions that use their brains more. There might be some more considering how the product feels for people to use. So for example, if you're doing a drone for people to get water in the outback community, you'll want something that isn't going to break down and stuff. So there's a bit more consideration. But if you're just building a pre-built drone and it breaks and there's just a bug in it that keeps going on, but you've worked out some whack solution like pressing a button 10 times and pressing another one, you're not going to feel compelled to fix that bug. You're just going to leave it there because you're the only one using it. It's just for recreational purposes.
Participant 4:	15:08	Yeah, as so-and-so said. Pretty much if you put something in front of a student that says, oh look there's something and it's

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going to help this poor person living in another country, they're going to be like, oh no, they'll have a reason to do it and they'll have more motivation to do it. But if you go, oh no your house, you don't have anything to do when you go home, you've got to make this so you can have some fun time, some video games or something when you get home, they're not going to have as much motivation because they're going to go, oh I have something like this at home. I [inaudible 00:15:40] need it.

Participant 2: 15:40 Yeah. I think if the point of the project is just to learn some skills, it's not that effective and it's certainly [inaudible 00:15:47] motivating. I don't feel motivated to do it and do it well. I'm not really as interested in the project. But I think when you're given a project where it's a problem and how do we fix it and in that you learn skills, I think that would be a lot more beneficial. And I wish that a little bit more of the projects and did that.

Researcher: 16:13 So let me finish off with this question. We talk a lot in technology subjects and in your case I-STEM about problem solving. I'm sure you would've heard that a lot. And here's a brief and we're going to do some problem solving. Again, and this is just a slightly different way of me saying what I just said before, but if I was to come up to you and say, look, this subject is about problem understanding and how we respond to that, would that make a difference to you?

Participant 2: 16:48 Yeah.

16:48 I think it depends what you identify as problem understanding. Because if it is some simple problem that sounds like it would just be, yeah, design something like a problem being like, oh, so and so doesn't have enough bag decorations is something that you just sit down at your computer, design something in Fusion 360 and then sit there for the rest of the year. But if you're presenting it as problem solving, as in you're solving large issues that engineering is applicable to. So there's obviously issues that engineering isn't the right thing to solve it with. Then yeah, I think that would make it a lot more interesting.

Researcher: 17:38 Well, okay, that's helpful. Let me give you another example just to come back to something you said before about flying drone in an outback community to get water. So someone's come up to you and said, the problem is that those people can't get access to water. And the solution is we'll get a drone to go and get the water. Perhaps from a problem understanding framework, if we go in, first of all, not thinking about how to solve the problem to understand the problem, maybe the first

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question would then be why do those people not have eater? Why is this a problem?

Participant 4: 18:10 Because most of the people live in, most of the people live on the shoreline in Australia. So they're like, we don't need a supply outback because there's not many people there. We need to supply the people who are on the shore. So a solution would be to encourage populations not to just mass on the shore, but to somehow mass, so evenly spread them so water could be equally spread, not stopped at the waterline. Because there's such a high consumerism in that area. And also there could be more dams or waterholes that could easily supply those [inaudible 00:18:48].

Participant 2: 18:48 Yeah. So I suppose one part of that could be considering other ways that more efficient farming methods that use less water, better investment into people who know how to divvy up water really well. So how that is similar to people who design roads and stuff, they know how to divvy up traffic so that people can get to where they need to go in an effective manner without too many stops. And so you got to also add into it alternate methods, not just sticking with what you got.

Researcher: 19:30 So a different framework for understanding brings about a different way of thinking about all of those other things that are connected to the initial problem.

Participant 2: 19:38 Yeah. And I suppose some of those things, like the farming thing is somewhat a engineering thing, but then how individuals use water, that's more of a social thing, which isn't an engineering problem. So looking at it from not necessarily an engineering perspective on other ways to solve it as well.

Table 79 School A Phase 1 & 2 Follow-up Interview Data Reduction Table

School A – Concepts, Relationships, Propositions Identified in the Raw Data Follow-up Interviews		
Phase 1		
Concepts	**Relationships**	**Propositions**
Creativity Technology Understanding Innovation Maths skills iSTEM skills 3D printing Tech drawings Electronics How stuff works Class time Teacher to class session Whole theory sessions Learn by doing (stuff) Engineering Engineering Technology Engineering, more of a physical thing Practical Integrated Enjoyable Future job career choice Future careers Make the projects Job opportunity Global impact Mindsets on working Modern Engineering Technology alliances Share technology / ideas Empathy for culture Know people / religion / beliefs Closed off	Interaction between mechanical and electrical engineering. Adding the science and maths part into it. Learn maths, science stuff. Science and maths integrated. Learn engineering to get more people into roles in the future. One engineer can bring a lot of jobs for a lot of people. [R-P] Productive when its dark, get more done in a day. [R-P] Help other countries. No one knew until it was translated. We don't understand any of the words. How you would explain what it does.	Enjoy learning by doing vs. worksheets. Teachers should lead kids in the right direction. Give them a direction to go on and give them basic skills to build on them, so they can get where they need to be. Can specifically do stuff that I enjoy. No other class that can let you do that for a major work. Help you understand why certain bits fit together. Progress further. Everyone deserves their right. So that they know what issues they face and what will actually help them. Need better languages courses in Australia. Benefited [benefits] people if you've got a population that can speak a wide array of languages. More attractive prospect. [moving to Australia] They are going to have an easier time. [immigrants] Imagine the amount of work that could be done if engineers from Australia were able to properly communicate with engineers from some other country who speaks a different language. Doing languages from early education, so even incorporating different languages into preschools.
Phase 2		
Concepts	**Relationships**	**Propositions**
Memory skills Intelligence Humanitarian side of engineering Engineers without borders Engineering mindset Optimising manufacturing Get products cheaper but higher quality	Interact with your target audience. No involvement with culture or community. Project that involved other people and had an actual need and connected us.	The connection is really cool because there's a lot more in technology today than just getting the product as efficient as possible. I feel like especially Apple, you can see that they've put a lot of effort in making their operating system and their actual hardware seem a lot more alive.

School A – Concepts, Relationships, Propositions Identified in the Raw Data Follow-up Interviews		
Design languages Simplistic design Respect Understand Honour Interest Interactive elements	I think it depends on what you identify as problem understanding.	It's something that's quite approachable. Something that differentiates them a lot. I spent a lot of time trying to work out. But in doing that it made it a lot nicer to use because it was more comfortable. I wanted to make it nice to use. More enjoyable for them. So, enjoyment. They actually get able to enjoy what they've purchased if they do purchase something. Well I believe most technology has been getting off track. But I feel like they should focus on user comfort. They risk quantity over quality. Making the projects a little bit more involved with connecting with other people and things.

Appendix J – School B, Phase 1 & 2 Follow-up Interviews, Audio transcripts, Data Reduction Tables

School B - Group 1 - Phase 1

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Researcher:	00:00	Thinking back or looking back on what you've just done. Do you think that you might be able to express what you've drawn to someone with some keywords? Let's say someone comes through the door and said, "Oh, what did you draw?" And you say, "Well, I don't have my drawing with me, but here are the keywords that came out of that." What sort of words would you use?
Participant 2:	00:18	Opportunities?
Participant 3:	00:19	Yeah, I have opportunities as well.
Participant 4:	00:23	Yeah. I have opportunities as well and communication.
Researcher:	00:25	Okay. So opportunity, opportunity, opportunity?
Participant 4:	00:28	Yep.
Researcher:	00:28	Communication and-
Participant 4:	00:28	The links between them.
Researcher:	00:31	Opportunities and-
Participant 4:	00:34	Communication, and just the links between different areas.
Researcher:	00:38	So can you elaborate on that? That sounds really interesting.
Participant 4:	00:42	Different things, different aspects of learning the language, and then how they are connected. There are similarities and differences.
Researcher:	00:48	What do you mean by opportunities? What kind of opportunities are you talking about?
Participant 2:	00:52	Like opportunities for more cultural understanding. So Australia has a lot of problems politically with Indonesia, and if we understood their language a bit easier, then we might be able to understand their culture better. And then we'll have more understanding with them and also opportunities in jobs and to go to university to study Indonesian.
Researcher:	01:15	That's interesting. Do you think that the culture, that understanding of the culture would lead to a learning of the language or is it in reverse?

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Participant 2:	01:22	I feel like both ways. If you're really interested in the culture, that will probably inspire you to learn the language and being inspired to learn the language then helps you learn even more about the culture that you wouldn't have been able to learn from English sources.
Researcher:	01:40	Your comment about opportunities?
Participant 3:	01:42	So I think mine's also similar to her with the jobs and how there'd be so much more, so many more opportunities by understanding and learning Indonesian. Like we could have job opportunities in Indonesia itself by learning about Indonesian culture and also how to speak, write and read in Indonesian. And you'd also have ... like jobs even here, jobs that require Indonesian speakers, or even just putting that you've learned and you are fluent in Indonesian on your resume would give you better opportunities for good jobs as well. And yeah, that's basically what I talked about with opportunities. And it also gives us a better understanding of Indonesia itself.
Researcher:	02:26	So when you talk about job opportunities, are they particular types of jobs?
Participant 3:	02:30	I think it'd be more international relations when there's businesses with ... since Indonesia is such a close country to ... it's the closest one, I think, to Australia. There's lots of different ways that we're connected through businesses, maybe like exports and imports and other businesses types where it's required to speak both languages. Because I feel like there's many jobs that require Indonesian speakers because it's related to Indonesia and Australia.
Researcher:	03:03	So how do you think that your motivation, your original motivation, to do this subject could be influenced by these keywords that are coming out and other keywords? So we've talked about opportunities and communication. What are some of the other ones and how do they relate to your own personal motivation?
Participant 2:	03:20	Family for me because my family learns Indonesian and both my siblings do Indonesian at uni so that was a big motivation for me because I would like to talk with them in Indonesian. But also just the interest in it because Indonesia's is one of my favorite countries to go to and it's just really cool, so yeah.
Researcher:	03:48	What kind of concepts were difficult to draw?

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Participant 3:	03:50	I think it was kind of hard to draw about what we're learning. More specifically, how we're reading it, how we're writing, and how we're learning how to speak as well. I think it was just hard to draw that and kind of elaborate more on that because I've written it down, I just didn't know how to elaborate further past reading, writing, speaking.
Researcher:	04:09	Would you describe reading, writing and speaking as the three key areas of the subject?
Participant 3:	04:17	I think yeah, when you're learning Indonesian those are the main three, but then it's also linked with learning about Indonesian culture as well, which is something I expected that we'd learned about when we're coming here. And also religion.
Researcher:	04:33	Are they equally represented in the course or is culture a bit of an afterthought?
Participant 2:	04:36	I think that it is represented, but ... We're learning new different aspects of the culture by learning new words and how to speak. So we've already learned all the basics because we've been doing it for a longer time, so we know everything, we just have to apply it and we're applying it to different aspects of Indonesian culture, like Indonesian food, Indonesian singers and everything-
Participant 3:	05:01	Movies, celebrations-
Participant 2:	05:01	... movies, films, yeah. Celebrations and rituals ... No, religious traditions, and stuff like that.
Researcher:	05:10	If I ask you this question about rationale, why do you think people think that language is something worth pursuing? What do you think the rationale is? Like was the subject presented to you with a rationale or does it feel like there's a rationale coming out of what you're learning? Is there a reason or is it just that you just happen to have this personal interest and it happens to be offered and that's why you're doing it?
Participant 4:	05:36	Well, I [inaudible 00:05:36] about like intelligence and overall knowledge, because learning a new language really improves your memory skills because you've got to remember new words and sentence structures and it just expands your knowledge in a range of different ways and not only in just that one subject, but across different subjects and to English speaking skills as well, not just-

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Researcher:	05:54	Is that right? So have you found that personally?
Participant 4:	05:58	Yeah. I don't know, I just generally feel like it expands your mind. Sometimes when I'm writing in English I'll randomly write a word in Indonesian-
Participant 2:	06:05	I do that with 'and' a lot.
Participant 3:	06:07	... 'Thinking' as well.
Participant 4:	06:08	So yeah, I think it just expands, I feel like, your brain's function. It just is constantly thinking in a different kind of way to people who don't know multiple languages.
Researcher:	06:22	So if I could just come back to you, you just mentioned that it affects your thinking. Do you actually start to think in Indonesian?
Participant 2:	06:29	Yeah, sometimes.
Participant 3:	06:30	Yeah.
Participant 4:	06:30	Yes, partly.
Participant 2:	06:31	Yeah, there's some-
Participant 4:	06:32	Some specific keywords-
Participant 2:	06:32	Keywords that like 'and' [crosstalk 00:06:33].
Participant 4:	06:33	'And' and 'because'.
Participant 2:	06:35	I say ... Yeah, because [Indonesian 00:06:40]. I always say that in my head. [crosstalk 00:06:43]
Participant 4:	06:42	Yeah, same.
Researcher:	06:43	Does that kind of freak you out from time to time?
Participant 4:	06:45	Yeah.
Participant 2:	06:46	Yeah, it does, but I guess it also shows how much we've progressed in learning Indonesian and I think I find that fascinating.
Participant 4:	06:53	Yeah.

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Researcher:	06:54	So you're coming into this in year nine and you've only done, say, three terms of it now. Were you doing it in seven and eight as well?
Participant 2:	07:01	Oh, I've been doing it since kindie.
Researcher:	07:03	Oh, okay.
Participant 2:	07:03	Yeah.
Researcher:	07:05	Right. Okay. So this is just one long, big progression for you.
Participant 2:	07:10	Yeah, kind of.
Researcher:	07:12	And do you feel like you've had that many years of progression, so you're in year nine, do you feel like you are five or six years down the track?
Participant 2:	07:18	No, it kind of feels like it's just been like ... it doesn't actually feel like eight years or nine years. No, it doesn't feel like 10 years at all. It just kind of feels like ... it doesn't feel like that long. It's kind of weird.
Researcher:	07:32	Do you feel like you're reasonably confident then? So do you think, "Oh, okay. I know I'm learning Indonesian, but I think I can actually go to Indonesia now and get around."
Participant 2:	07:41	Yeah, when I was in Indonesia, I was able to read signs and be like, "Oh, that's where that is." But still, there's a lot of intricacies and it's hard to understand actual Indonesians talking because they talk so fast, like in any other language. So, it just helps a lot with being like, yeah, if I ever got lost in Indonesia, I could tell my way around pretty well. It would just come to the speaking part where it's a bit difficult sometimes. And listening.
Researcher:	08:12	So when you say that you start to think in Indonesian and you start to use the occasional word in your English writing, do you feel like you're still yourself or is there a new identity appearing? Do you get a sense of any of that?
Participant 4:	08:26	Not really. I just feel like it's just another element that's there. It just kind of expands, just like-
Participant 2:	08:33	Yeah.
Participant 4:	08:33	... how I think, I guess.

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Participant 2:	08:35	Just an expansion of ourselves.
Participant 4:	08:37	Yeah, pretty much.
Researcher:	08:38	What about when you think about some of your friends or other people at the school or people that you might know who don't speak another language, how do you think that your experiences now in language learning influenced the way you think about those people? Do you look at your friends and go, "Wow, I just can't imagine not knowing another language."
Participant 3:	08:56	Not too much.
Participant 4:	08:57	Not really.
Participant 2:	08:58	I don't really think of them any different.
Participant 2:	08:59	Just our understanding of the culture, like the Australians that go to Bali and just wreck havoc. They have almost no cultural understanding at all of how pretty Bali actually is and how it's so much different and how every Indonesian island is so different from each other. I kind of do think of those people differently because they don't take time to really learn about where they're actually going. They just go there to get drunk or to ride a motorcycle. So I kind of do think of them a bit differently, but as with people that are close to me, I don't really think of them that differently.
Researcher:	09:42	Do you think that languages, in your case, Indonesian, could fit along any other subject selection? Could it fit into any secondary school learning pathway? I'll be more specific. Let's say you were really focused on one particular career that needed a solid set of skills in that particular area. Would a language, well, a language like Indonesian, would that fit in there as well?
Participant 4:	10:07	I think so. Just in general with ... Well, if it was just anything really ... Well, especially if ... it gives you opportunities to pursue that path by both in Australia or in Indonesia, or you could have opportunities to go travel for a specific project that your work's doing over in Indonesia. It just gives you a little more opportunities in that way, I guess.
Researcher:	10:31	Do any of you have aspirations of working in international development in some capacity?

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Participant 2:	10:37	Yeah. I think that I do want to ... when looking for a job or when working, I do want to go to different places. I don't want to stay in just Australia and I feel like Indonesia would be a place I'd go because I understand the language and the culture now, but it's also close to Australia and I think it'd be a good opportunity to find jobs and I think it'd just be a good place to go there.
Researcher:	11:02	You made the comment earlier about the political problems that Australia has with Indonesia. To what extent do you think that an understanding of language and culture can really make a difference to Australians' understanding of how to relate to one of our nearest neighbors?
Participant 2:	11:19	Kind of like ... you know when you hear a story from somebody else, but you weren't actually there to experience what actually happened?
Researcher:	11:26	Mm.
Participant 2:	11:27	A lot of things can be lost in translation, I feel. There's a lot of words in languages that can't actually be expressed in English because they've got deep cultural meanings or something like that. And I feel like a lot of things would just get kind of mistranslated or not really truly understood by the opposite parties when they're having political discussions or when the news is reporting, because it's so easy to look on other countries or even the past, like why would they do that? But you weren't actually really there to experience. So not really knowing their language is almost not like being there to experience what actually happened.
Researcher:	12:09	What sort of things do you think you would like to see more of in the subject? Let's say it was just completely open [inaudible 00:12:16] for you. I'd like to see more of ... ?
Participant 3:	12:17	I think I'd like to learn more about the culture and how they live and their values in Indonesia.
Participant 2:	12:24	Their values.
Participant 3:	12:25	That's something I want to learn because as she said earlier, it's obviously much different to Australia and there's lots of deep rooted cultural things there that we wouldn't understand here. So I do want to learn more about it whilst learning the language itself.

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Researcher:	12:42	You placed quite an emphasis there on values. Can you elaborate on that a little bit more? What kind of values?
Participant 3:	12:46	Well, one thing that was pointed out, Indonesians are very respectful and I saw that a lot by the way they speak and how we've been learning, how to say stuff. And so there's lots of things that we could say to offend them very easily. And then I think that's vice versa as well. So I want to learn more about their values and what they prioritize and I guess how they live so then we can fix problems like the mistranslation.
Researcher:	13:21	Was that remotely interesting for you?
Participant 2:	13:21	Yeah, I guess.
Participant 3:	13:21	Yeah. It just helped me pinpoint more about why I was studying this language.

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researcher:	00:00	So with us in this interview, we have two languages students, one doing Russian, one doing Tamil.
participant 1:	00:07	Tamil, yeah.
researcher:	00:07	Both Year 10. And I have a teacher from Design and Technology from the students that we had previously. Looking back on what you've just drawn, if you were to walk out the door now and say, "Hey, I did this thing." And they said, "What did you do?", could you describe what your concepts are in terms of keywords?
P 2 - Teacher:	00:25	Generally or with regards to ours?
researcher:	00:28	With regards to your concept map.
P 2 - Teacher:	00:30	Yep.
researcher:	00:30	So firstly, with regards to your concept map, but then if you say, "Oh and I also thought this," that's okay.
P 2 - Teacher:	00:37	Well I can start. Design Tech, if I was to encapsulate what that is in a couple of words, I think it's the linking of critical and creative thinking, that interplay.
participant 1:	00:50	For me, it's mainly the culture because India has a lot of culture and whatever. And also just the hidden history that people haven't really known about and subcontinents and whatnot, things like that. And also food. I like my food.
participant 3:	01:08	For me, it's about culture and self-expression, particularly pertaining to my great-grandmother, I'm named after her and she was Russian.
researcher:	01:20	So do you feel a strong sense of cultural connection to a past, even though it doesn't make up much of your present?
participant 3:	01:28	Yeah, in a way because my mom is Australian and my dad's Argentinian. But yeah, I was named after a Russian, so I feel that connection of it more strongly than I think other members of my family would.
researcher:	01:46	Do you think you understand why?
participant 3:	01:49	Not really. The language did click with me in a way. When I started learning, it was almost like I almost got it immediately, but I'm not sure that has anything to do with anything like

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		family history or whatever. I've had no major prior exposure to the language.
researcher:	02:16	What other key ideas before we move on? Are there any other key ideas?
P 2 - Teacher:	02:20	I think for me, I think authentic design and I've put this phrase of mine about making the world a better place. I think there's a notion of there's got to be the purpose around the design is, and they use in the curriculum, they talk about preferred futures, but I think the value of design stems from that philosophy that through critical and creative thinking through actions, whatever it might be, the intention is to make the world, person next to you, whoever it might be, through your design processes, a little bit better. And so there's got to be an element of, I'm not sure if altruism is the right word, but helping others through the design process and I think the value in this subject is that. And I believe sometimes, that gets misconstrued about making something for yourself. And I think that devalues the subject sometimes.
researcher:	03:23	Does the concept of a preferred future or altruistic motivation come out in languages?
participant 1:	03:30	No, not really. It's more for you in the present. Because for me, it's my mother tongue, so I've been speaking it and reading it and writing it since I was a child. I lived in India for two years and then we moved here. But same, when I go to India, I feel like I've always been there. When I see people, I'm like, "Hi," it's... Yeah.
researcher:	03:52	I find that a very special moment when you make that connection because it's very hard to describe.
participant 1:	03:59	Yeah.
researcher:	03:59	You can't really explain it to people. Somehow a meeting of culture can be very powerful, so-
P 2 - Teacher:	04:09	Sorry, can I not have a rebuttal to that, but discuss an element of that?
researcher:	04:12	Of course.
P 2 - Teacher:	04:14	So I think what you're talking about actually is a preferred future. I think what I'm hearing is that through you learning this language, you can make a stronger connection. So in the future,

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you have these stronger connections and culture is more greatly accepted, is flourishing. And these are all preferred things that we'd like in the future. We'd like this, I guess, understanding, embracing, of these diverse cultures that requires an investment of time, education, learning languages. I think, to me, learning a language is almost the ultimate form of trying to understand someone else's point of view because it's the way that we interact with each other all the time.

05:12 And so, from language comes food, comes art, comes history, and these things create an understanding for you, for the people around you, for you telling it to me, right? Which creates this preferred future or this future that is diverse and understanding that, it's not a utopian environment, but it's definitely a preferred environment. I believe that currently, and I'll draw an ongoing tangent here, but I think we're losing that. And what we're seeing around the world and we're seeing in Australia is the opposite, is devaluing culture, is English should be the only language, things like that, which actually takes away from this future that we'd like to see. I would disagree that it's not about it, I think you're absolutely describing the preferred future. That's just me.

researcher: 06:08 I've heard it said that English is the international accepted language but not all knowledge is constructed in English. What do you make of that?

participant 3: 06:21 I think that's a very true statement. English has its limitations in especially, you learn this once you learn another language, but with the different vocabulary and the slightest different interpretations of words, it can expand the way you can share knowledge.

researcher: 06:47 How do you feel about that statement?

participant 1: 06:49 I think it's valid because English is such a new language compared to all the other languages that have been. So all of those other cultures and languages could have picked up on knowledge that English hasn't found yet, kind of thing. But yeah, I completely agree with what she said.

researcher: 07:06 Coming back to the teacher's perspective then, if I was to say to you, the fact that not all knowledge is constructed and therefore, by extrapolation, not all design knowledge is constructed in English, what kind of reaction or challenge does that present to you?

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P 2 - Teacher:	07:22	I think I can disassociate that, the idea, I think the communication of design and how we communicate design to get certain results is not limited to English. And in fact, I don't even think it comes into it, to be honest. If you look at half the modes in which we look at the styles of thinking around this, it's not anchored off the English language. If you look at a really rudimentary sketching, pictures, right? When we're prototyping or testing or building to think, there's no language such as English involved in that necessarily.
researcher:	08:17	It's funny, isn't it? Because when you look at hieroglyphs on an Egyptian wall, it's very hard to make sense of those. But when you look at the works of da Vinci, it's very easy to make sense of those, but neither of those are communicated in English.
P 2 - Teacher:	08:29	That's right.
researcher:	08:30	So there's diversity and complexity and simplicity all in the one thing. Thinking more broadly now, I'm keeping an eye on the time, thinking more broadly now about how you think what you're doing in your subject goes beyond your local environment, goes beyond this environment, beyond Canberra, beyond the ACT, pushing beyond our shores, what kind of impacts, effects, what sort of things do you think about as you consider that the world is a much larger place than just where you are right now?
participant 3:	09:03	I think these days, because we interact online a lot, it's a lot more important to know other languages in order to experience more. There's a ton of beautiful indie games and stuff, and I don't know if you're probably familiar with that, don't want to be condescending and just checking, but I think not everyone is able to translate their works or willing to translate their works. And I think then, it has an importance, especially in such a globalized world, that you are able to interact with a space outside of the English spaces.
researcher:	09:50	You don't think that translators can cross a lot of those barriers?
participant 3:	09:54	I think translators can but, again, sometimes, there's almost a reluctance.
researcher:	10:01	Well, let me rephrase the question. To have a more genuine understanding of the language, does that go so much further than what a translator could offer?

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participant 3:	10:09	Yeah. You can never translate something 100% with all of the cultural context.
researcher:	10:15	Coming over to the Design and Technology teacher's perspective, as you consider the impacts of what you do beyond your local borders, what responsibilities do you think you have, if any?
P 2 - Teacher:	10:24	I interpret that question about in regards to what can I teach students and then that they can take into their world and beyond our local community or whatever it might be. And I think it is my responsibility to give the students skills and strategies for thinking that they can move beyond or integrate into all areas. And so I think design in a lot of ways is about framing problems and investigating and examining problems and creating solutions that aren't always fixated on the common notions of what design is. For example, woodworking, right? Because I'd be naive to think that every student's going to be a designer that's doing my course.
	11:15	And so it is my responsibility to develop skills that can be utilized in whatever manner and direction they take, their further studies, their life. Because at the heart of it, I think that critical and creative thinking, and I know that they can be used as buzzwords, but if we develop both those things, regardless of context, business, economics, whatever it might be, we can apply those. And if we go further, when we're looking at, we've got human-centered design or empathetic design, finding out about the person, regardless of whatever field you're in, politics, you name it, that is only going to be a good thing. For me, that's my responsibility to teach or move beyond the school environment is that they have the skills and then they can excel in helping other people. I'm a bit of a socialist leftie. But can they do that? And then I succeed if they can.
researcher:	12:14	What were the things that you perhaps didn't expect in your languages study and what are some things that you would like to see more of?
participant 1:	12:24	Well, we talked a lot about social issues that happen around the world and mainly in our part of the world and I didn't expect that. I thought it would just be about literature, arts, and things that are mainly just around the language, not so much the culture. I knew we'd go into festivals and other things like that, but I never expected the social issues and the history behind those issues and why it's not so relevant in today's society.

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researcher:	12:56	Social issues within India or globally?
participant 1:	12:58	Mainly within India.
researcher:	13:00	Is that because, and I'm asking out of ignorance here, is that because the population is so large and there are so many different, I guess, could I describe them fairly as subcultures? Different cultures within India, that there are perhaps so many different interactions that to start understanding the culture, you've really got to start understanding the fundamental workings underneath. Would that be a fair description?
participant 1:	13:24	Yeah, definitely. If you just compare North India to South India, you see so many changes. In South India, we mainly worship statues, whereas if you go to North India, they worship dolls and stuff. It's the same god, it's the exact same god, it's just the way that we worship is different. And also the caste system. It's not as prevalent in South India today but if you go up to North India, that's all you hear about, just caste and things like that. So if you really want to understand all of India, you need to know why it's like that in the first place.
researcher:	13:59	And you weren't expecting that?
participant 1:	14:01	I wasn't expecting to go so deep into issues like this.
researcher:	14:07	And so, are there specific things that you think you'd like to see more of, either in Russian or Tamil?
participant 3:	14:13	The history of the language.
researcher:	14:15	You'd like to see more of?
participant 3:	14:17	Yeah.
researcher:	14:17	Right.
participant 3:	14:18	I've been able to do a bit of surface-level Googling research. It's not really research. But there isn't really a lot about why the language is shaped the way it is in classes. And I'd like to see more of that in just language courses in general. It's really interesting to me, but there's not a lot of material on it.
researcher:	14:47	In your subject, do you feel constrained? What would you like to see more of, as the teacher's perspective now again?
P 2 - Teacher:	14:52	Within curriculums [today 00:14:53] or within the classroom?

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researcher:	14:55	Curriculum, classroom. It's kind of an open question.
P 2 - Teacher:	14:58	Yeah, I think, I mean, my biggest I would love to see change is the historical optics of what the subject is because I think there are discrepancies between parents' views and what they pass on to students and then what the curriculum is at this stage. Yeah, so I think if we can break down those views on the subject, then the perception of what it is, I think will be [inaudible 00:15:30], there'll be greater flexibility there and a lot more open.
researcher:	15:34	Tell me, something I'm very curious about, and now we have a teacher's Design and Technology perspective on one side and a languages perspective on another side, arguably from a language that is not studied very often, certainly in terms of enrollment numbers, do you see your subjects sitting alongside other subjects equally?
participant 3:	15:52	I do believe that language study as a whole is one of the more important areas of study but that's not to say one particular language is more important than others if that makes sense.
researcher:	16:06	Yeah, that does make sense. So languages in and of themselves have value, rather than a specific language to the person.
participant 3:	16:15	Yeah.
researcher:	16:16	Do you see your subject as being one of those subjects which you think could fit equally alongside any other learning pathway?
P 2 - Teacher:	16:23	Yeah, absolutely. And I think the value that design has is that it utilizes and integrates every other learning area. It has to. And following that, that it offers so much that can be applied to other areas.
researcher:	16:40	So you say that it does integrate other learning areas by default?
P 2 - Teacher:	16:43	By default, has to. Because, I mean, it's about once you move beyond a hobby, we're looking at the world and how the world works and looking at the preferred futures of the world, you can't not look at the social sciences, you can't not look at mathematics. I always say that I think the creative process parallels the scientific process because when you break it down, it is about formulating problems, defining problems, testing, creating methodology and solutions that might work.

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researcher:	17:21	I wanted to ask specifically, you talked about integrating other subject areas. Now, there is the obvious and well-documented concept of STEM.
P 2 - Teacher:	17:30	Correct.
researcher:	17:30	Which integrates science, technology, engineering, and maths. Do you see that as an unnecessary over-integration of those subjects? And do you see the same potential for STEM-based activities in a Design and Technology course?
P 2 - Teacher:	17:45	Yes, I have strong views on this. So I disagree with the notion of STEM. I think STEM as a concept oversimplifies the integration of science, technology, engineering, mathematics, because I absolutely think that design has all those embedded in it and always has done if you move it beyond the hobby. And so I don't think there's a need for STEM, I really don't. I fear that schools teach STEM and do spaghetti bridges, right? And I use that analogy but what I mean by that is I think we default to just an engineering topic when if we really want to integrate all these areas, we have to bring those social sciences and humanities in, whereas I think they're really neglected within STEM, where we take out the human focus when we look at STEM all the time and it becomes an engineering course. And when you see examples of STEM units across the internet in schools, that is what I see it is. And I think that devalues the notion of an integrated course.
researcher:	19:03	Okay, I just want to pick up on that comment there because if you look at the syllabus in New South Wales called iSTEM, and the reason why I think this might be relevant to you is because when you open the PDF on your computer and you do a word search and you search for the word "indigenous" in that syllabus document, it's not present. And then when you look at the introduction to the subject, it talks about bringing females into the STEM field because they require different methods of learning to boys. What do you make of that?
participant 3:	19:37	Is it really that different? I probably don't have the best perspective on learning methods because I have challenges with mental stuff, so I don't really learn normally, but.
researcher:	19:54	How about the indigenous perspective? Being a language learner yourself, to have a very new syllabus, we're not talking about a syllabus that's been around for 30 or 40 years, does that seem unusual that it does not recognize indigenous culture?

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participant 3:	20:11	I'd say a little bit, yeah. So in science, we're looking at various historical perspectives of astronomy. And I think if it's ever going to cover the history of engineering or whatever, I think it does have to cover various cultures, perspectives, beyond European perspectives.
P 2 - Teacher:	20:37	I suspect, and carrying on from the discussion here, I worry who's writing the curriculum. Whose is this idea of English being... Is it in a European lens on a lot of these issues? Is this why we're not seeing these key focuses? And I think in Australia, it's a significant problem. And if it's just a time thing, then we're moving really slowly because as a comparison, when you look at New Zealand, the understanding and the embracing and the integration of the Maori culture within all their facets of their life and education is extremely significant.
researcher:	21:18	We hear this thing about preferred futures a lot. I wonder whether that was written at a time where we were perhaps less aware of the fact that the future is defining itself for us faster than we would like in terms of climate change, as an example.
P 2 - Teacher:	21:33	Yeah.
researcher:	21:34	I wonder if we still have the option to state what we think our preferred future is rather than saying, "Well actually, the actual future looks bleak. Therefore, your preferred future must look like this." Do we still have the choice?
P 2 - Teacher:	21:50	Yeah, great question. I think that's a fair statement.
researcher:	21:54	I mean, another way of saying that is, "Well, actually guess what? Thank you curriculum for saying I need to state my preferred future, but if my preference is based on anything like what my predecessors' preferences was, then my preference doesn't really count for much and there is only one future for all of us and that is to try and save the future." That seems to be the modern philosophy now. Whether that's fair or not, I'm not arguing one way or the other, but it seems to be often spoken about.
P 2 - Teacher:	22:22	Yeah. And I think possibly with that, are we disassociating ourself with a thing, which is this preferred futures education, this STEM, this thing with the here and now. Do we need to reflect more on what's going on right at this point? Or is it this fancy story that we need to be reflecting on?

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researcher:	22:49	Well, that came out in the languages, didn't it? Because our Tamil student here was talking about language as being part of the here and now. So it's that delicate balance, isn't it? Between what we do now together as we direct and how that might influence what happens in the future.
participant 3:	23:04	I think part of the significance of languages and design in a way is it's bringing people together by understanding them because in design, you have to understand really what people need and how to deliver those needs accurately. And in languages, you're learning about the culture. You're learning about how people of that culture interact with one another. It's less about a list of words and it's more about how those words shape mindsets and attitudes.
P 2 - Teacher:	23:45	Hmm. Profound.

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Researcher:	00:00	So, we have a group of year nine design and technology students. Okay, we've got six participants here in the group. When you look at your drawings, if you were to think about what you've just drawn and then turn around and tell somebody else about it, what kind of key words would come to your mind when you think about how you conceptualize, in your case, design and technology?
Participant 2:	00:23	Linking.
Participant 3:	00:27	Design process.
Participant 4:	00:27	Maybe conceptual design and then hands on.
Researcher:	00:28	What was that last one?
Participant 4:	00:31	Hands on and then conceptual design, like the two different [crosstalk 00:00:35]
Researcher:	00:35	Hands on and conceptual?
Participant 4:	00:36	Design, yeah.
Researcher:	00:36	Yeah. Conceptual design. Yep.
Participant 5:	00:40	Original.
Participant 6:	00:42	I think there was that was a thing for the planner around empathy. What was that thing? The design process.
Researcher:	00:52	The design process?
Participant 6:	00:53	Yes.
Participant 2:	00:56	Problem solving.
Participant 6:	00:57	Making stuff.
Participant 2:	00:59	Machinery.
Participant 4:	01:01	Emerging technologies.
Participant 5:	01:03	It lets me work with my own two hands.
Researcher:	01:05	Is that important to you?
Participant 5:	01:06	Yeah.

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Researcher:	01:08	And the reason why I pick on that one is because that's a slightly different key idea to the other ones. At least it sounds a little different. So, why is working with your own two hands important?
Participant 5:	01:16	Because I get to show my own creativity, and it's a lot less boring than typing on a computer.
Researcher:	01:24	Did anyone have these key ideas in their head when they were thinking about making a decision to do the subject?
Participant 6:	01:31	Yes.
Participant 3:	01:31	Yes.
Participant 2:	01:31	Yes.
Participant 4:	01:33	Yeah. I definitely thought about the hands on aspect. I wanted to do hands, make some stuff.
Participant 2:	01:39	Yeah. It was kind of disappointing when we had to go to online school, and we couldn't make stuff.
Researcher:	01:44	Right. Because of COVID?
Participant 2:	01:46	Yeah.
Participant 4:	01:47	But we're getting back into it now, which is good.
Participant 6:	01:49	For these unprecedented times.
Participant 3:	01:53	I was thinking more of the design process and digital design. That's why I mainly chose the subject.
Researcher:	02:00	Oh, okay. So, not that this is right or wrong, but a slightly different emphasis to your colleague here. So, working with your hands is important to you, whereas the conceptual digital is more valuable to you. That's interesting. What other key ideas can you link to your original motivation for choosing this subject?
Participant 5:	02:18	It can help with other subjects like with maths and science, with the designing and problem solving.
Researcher:	02:28	What do you think the links are between design and technology and maths and science aside from problem solving? Can you be a bit more specific?

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Participant 5:	02:36	So in DT, we use a lot of measurements, and we have to sort of build on those and work around them. And so, you have to understand maths while also understanding how to make something.
Researcher:	02:50	Perhaps I could ask it this way, and I'll ask this to the entire group. Do you ever come across, in design technology, are you ever taught a specific mathematical or scientific concept before you start a design project?
Participant 6:	03:08	Yes. Sometimes.
Participant 2:	03:08	Sort of.
Participant 5:	03:08	Sort of, yeah.
Researcher:	03:08	So, do they ever say, "Right, so this is going to be a bit mathematical. We just need to look at, for example, this part of trigonometry, because this is going to involve a few angles. So, we've just got to sort this out. So, we're just going to look at this and then we're going to solve this design project." Does that kind of thing ever happen?
Participant 2:	03:22	Yeah, with some of the assignments we've done, like laser cutting. We have to work out the width and the height and length of the board on the piece of wood that we're laser cutting onto.
Participant 3:	03:33	Yeah, it goes both ways. It goes from, you could say, maths to DT, and DT to maths.
Researcher:	03:39	Okay. So, it travels both way, the relationships between designing and actually realizing, making the product and understanding the concepts underneath.
Participant 4:	03:49	Yeah. It's almost like a pie, the mathematical ideas that we might learn in maths and then applying it to design technology. And I think that helps, because we can see a physical outcome, like the design we've made or...
Researcher:	04:02	Were there any part of parts of the subject that have come up that you weren't expecting?
Participant 3:	04:06	There's lots of research tasks.
Participant 5:	04:09	Yes, there's a lot of research and writing tasks, and not the best.

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Researcher:	04:14	So, when you say that you weren't expecting to do research and writing tasks, was it the fact that you weren't expecting to do that much writing?
Participant 5:	04:22	Yes.
Participant 2:	04:22	Yeah.
Researcher:	04:23	Or the research?
Participant 2:	04:24	Both. It's a very heavy workload, I think, for a sort of more artsy design-y, sort of hands on subject. There's a lot in there.
Participant 3:	04:35	I expected to do research for inspiration and to find new ideas, but I didn't expect to write a lot on the ideas that we found.
Researcher:	04:46	Sorry, you were going to say something?
Participant 4:	04:47	Yeah, compared to other years where pretty much almost every assignment we were making something, and that might be because of COVID, but so far, every assignment has just been like a research task. We've been making things, but definitely less than previous years, I would say.
Researcher:	05:04	Could you put a percentage on it as in, we make stuff this percent, and we do research and writing this-
Participant 6:	05:11	Probably 30% making and then the rest research and [crosstalk 00:05:15]
Participant 2:	05:14	Yeah, like 40/60, 30/70 ish.
Researcher:	05:17	... Right, so the majority is on the research and writing.
Participant 2:	05:20	Yeah.
Participant 3:	05:20	Yeah.
Participant 6:	05:20	Yes.
Researcher:	05:22	Would you prefer it if that was flipped?
Participant 2:	05:23	Yeah.
Participant 3:	05:24	Yes.
Participant 4:	05:24	Yes. Definitely.

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Participant 5:	05:25	Honestly, I preferred research and-
Participant 6:	05:29	Research is fine. [crosstalk 00:05:31]
Participant 5:	05:30	... And writing, I prefer it sometimes over the actual making, because it's just interesting to research and just dive really deeply into certain emerging technologies.
Participant 4:	05:43	Yeah. I think that's true as well. I do enjoy the research, but I think there's a time and place. I just really like getting into the workshop and applying the things we've been learning about.
Participant 5:	05:54	Yeah. There's no point really researching if we're not going to apply ourselves to that topic.
Participant 2:	06:01	Yeah. I get that. Sort of needs to be an even balance between the two, and not so much as one side's more than the other.
Researcher:	06:08	If I was to suggest to you that there was a rationale for doing the subject, do you know what I mean by rationale?
Participant 2:	06:14	Yes.
Participant 3:	06:15	Yeah.
Participant 4:	06:15	Yes.
Researcher:	06:16	What do you think the rationale is for doing this subject?
Participant 6:	06:18	You can still learn a lot from it in both aspects of it, but it's a good subject. You can research more, learn more, work more. So, it's pretty good. But there is a lot of other stuff that you wouldn't expect is in it, like the amount of planning needed. You can't just go and make something. You know you need to plan before you make something, but you can't just go and make something, unlike in earlier years, back when you would have first started D&T, like if you said, "Oh, can I just write a drawing on a piece of paper?" And in a few weeks, you're going to go and make it. And now it's like, "Okay, I have to do research, put it in a document and submit it." And then we have to do more research in the woods unit, and now you can go and make it, but that's going to require work to say, "You can make it," and so, it's more complicated and a longer system.
Participant 2:	07:11	Yeah. I think the rationale is important, because it shows the reasons why behind you chose to do something.

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Participant 4:	07:18	Yeah. And it also makes you think a lot about why you're choosing these specific aspects of your design. There's no point having something if it's not going to serve some sort of aesthetic or functional purpose in your design.
Participant 2:	07:33	Yeah, because going into this subject, I definitely didn't think I was going to be doing as much writing and research, because if I had known that we were doing this much and having such a heavy work load, I probably wouldn't have chosen D&T.
Researcher:	07:48	Let's imagine that there's a pond here, and we drop a stone into the pond, and the ripples go from the center out. You know that idea?
Participant 2:	07:54	Mm-hmm (affirmative).
Researcher:	07:55	When you think about your subject and your involvement in the subject, how far do you think those ripples go into society throughout the world? How far do you think what you're doing here extends?
Participant 2:	08:06	They probably don't even leave the classroom most times. Maybe talk about it a bit at home, but it's nothing really important that we're really... I mean, it is important about the sense of learning the skills. Like so far, we've made a key chain, so I wouldn't say it's rippled very far in society or anything like that.
Participant 3:	08:25	I kind of think the opposite. I think the skills that we learn now will actually benefit our future. So, it may not ripple out far now, but in the future it may affect us and help us.
Participant 5:	08:38	Yeah, they're so many problems in the world today that can only be solved by design and by people thinking through, okay, how can we create something that will fix this specific issue? So I feel like it's very important for the world for people to learn design. And if people didn't learn design, then where would we be today? We wouldn't have much machinery. We wouldn't have anything that we have now, so I think it's really important.
Researcher:	09:10	Do you think that the things that you design and the out workings of this subject, as the ripples do go out a little bit further, that some people, in some cases they might, and some cases they might not go as far as the others, what happens when they bump into other cultures?
Participant 6:	09:27	It depends on their system.

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Participant 2:	09:30	What do you mean by other cultures?
Researcher:	09:32	Well, for example, we use technologies here in this country that weren't designed or made here, but they've come here, and they've impacted the way we live and the way we behave.
Participant 6:	09:42	Different countries have to build differently, because different temperatures, different climate and different material can react different. That's to say, steel is strong, but when it gets cold enough, it's super weak. So, just say Antarctica was way colder. Sure, we build steel stuff here, but say we you lived in Antarctica. They couldn't use steel there, because it would be too cold and brittle. So, materials can alter between countries and cultures because of many aspects. And so, they might completely learn using different materials they have, and maybe we don't. And so, they've had to learn to design a different way, so it would change throughout the world, really.
Participant 4:	10:26	Yeah. I understand what Isaac's saying. And I think that the idea of design and the idea of these new technologies, them traveling to these new cultures, I think it encourages a lot of innovation. How can I apply this to this new culture? How can I apply this to your country? And I think it furthers the innovation and development of new designs and ideas, maybe.
Participant 3:	10:51	I learned Indonesian as well as D&T, and Indonesia sort of doesn't, they make things for other countries, but they don't make things for themselves, which means that their country can be quite poor at times in certain areas. So, I think it's important that countries sort of rebound off of each other so that, "Hey, your country is better at designing things than my country is. So, would you be able to try and help us solve this problem? And we will help you solve one of your problems."
	11:25	So, I feel like it's important for the world to really develop. Like in the Industrial Revolution, countries sort of rebounded off of each other's ideas and inventions, and led us to where we are today, so I think that's important.
Researcher:	11:40	I once heard it said that the international language of the world is English, but not all knowledge is created in English. When we think about technology being developed in other parts of the world and shipped around the world, how do you respond to that comment about English is the international language, but not all knowledge is created in English?

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Participant 2:	12:01	Well, in ancient times, it was Roman and Latin and all that. And I think at the beginning of the Industrial Revolution, China and Asia were sort of leading. So, most of the information was in Asian languages, and that's where their technology was coming from.
Researcher:	12:22	Do you think technology plays an important role in how cultures evolve?
Participant 2:	12:27	Yes.
Researcher:	12:28	And how they impact each other?
Participant 2:	12:29	Yeah. How they communicate with each other is a big part in technology.
Participant 4:	12:35	Yeah. How they function as a society, how they use their resources. I think it influences everything.
Researcher:	12:43	So, that's zooming right out. Let's zoom right back in now. When we think about what we've just said, and when you think about what you're doing now, can you see at all now a linkage between what you're doing now and that potential future?
Participant 3:	12:56	Yes.
Participant 4:	12:56	Yeah. I would say yes, because we're learning about emerging technologies. And potentially these technologies we're learning about could change the world, could influence how our daily lives are structured, how our society functions. And I think learning about that is important, so as it could be an important part of our future.
Researcher:	13:20	The word future has come up quite a lot. And kind of in the common language these days, there's an idea of, "We need to protect our future." And the obvious one in that sense is climate change. When you think about your future and when you think about designing in this particular subject and how we impact other cultures and so forth, do you see a sense of urgency there? Do you see trouble on the horizon?
Participant 5:	13:47	Yes. I see a lot of trouble, and I think that needs to be change in what we're already doing now. So, with pollution, we could think of renewable energy. And if we didn't teach younger people about that, then they'll follow their parents, and that can lead to more problems if they don't evolve and learn.

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Participant 2:	14:10	I think that design is sort of the language of the future, because right now people are designing things for themselves to make money, not for the world to be better. You know what I mean? Generally now, inventions nowadays are just to make money. So, I feel like in the future, design needs to change slightly so it's not looking at the, "Can we make something that's better than everybody else, just so we can make money?" We need to think, "Can we-"
Participant 6:	14:38	[crosstalk 00:14:39].
Participant 2:	14:39	... Yeah. "Can we make things together that will help change the way the world functions at the moment?"
Researcher:	14:46	What other subjects do you think could go alongside what you're doing now? Does it fit with anything.
Participant 4:	14:51	Other STEM subjects, like science.
Participant 6:	14:54	Commerce.
Participant 4:	14:54	Yeah, commerce, like looking at maybe how your designs influence the world.
Participant 2:	14:58	Art.
Researcher:	14:58	Art?
Participant 2:	15:01	Art. The more creative side. So, designs, new ideas and concepts of how you can perform the ideas.
Participant 4:	15:10	I don't do it, but maybe international relations, like looking at how the world relates to each other. You could see how the designs, how innovations influence that relationship. And also maths for more the design, kind of how you're actually designing things.
Participant 3:	15:29	Language, because in the future, jobs, there's going to be a lot of design jobs overseas. Like in specific European countries, they're like the design capitals now. So, just learning languages can really help you in the future with design.
Researcher:	15:47	So, you're also studying language, and you're the only one who's doing technology and languages.
Participant 3:	15:51	Yep.

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Researcher:	15:51	If I can just throw that to the rest of the group, what do you think of that comment?
Participant 4:	15:55	Yeah. I have to agree with that, because not every opportunity is going to come to you. You have to branch out to other places.
Participant 5:	16:05	Yeah, I agree with that. Different opportunities might appear in different places, and it's not always going to be where you are or what language you speak.
Researcher:	16:19	Has that ever come up in the projects that you design? As in, "We're going to design this project, which could potentially have this kind of relationship with this part of the world or this particular culture." Has anyone ever really tried to map out another subject next to yours in that sense?
	16:40	So, just to give you an example. I can't use your name, but for you, the connection between languages and technology is very obvious and very real and very rich. Has it ever crossed your mind through the projects that you've been been designing and making that you might think, oh, this is going to have a wider implication potentially with someone else who doesn't speak my language?
Participant 4:	17:02	Last year in design, or it might've been a few weeks ago, we designed our... Was it... It was so long ago. We were looking at different cultures overseas-
Participant 6:	17:16	[crosstalk 00:17:19].
Participant 4:	17:20	... And their toys they might use. And we were designing them and making them, and I think languages can bring to design the idea of the different perspective, how different cultures or can give an idea that there's other people, and they have other problems other than you and how that's different. I don't know.
Participant 3:	17:41	Yeah. It kind of gives you a new perspective to look at things from, because design, even though it has all the planning, and it may seem really tedious, it also kind of forces you to think in the way that the person you're making this for might have to think. Like with the empathy part of the design process, that's really important, because it makes you actually get into the issues and think, if I was this person, what would I want from this product? And how would I get that?
Researcher:	18:11	You're doing two electives in year nine and 10?

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Participant 3:	18:14	Yes.
Participant 4:	18:14	Yeah.
Researcher:	18:16	Let's just say, let's just pretend for a second, that you could do three electives. Would you be likely, say more or less than 50%, to consider doing a language alongside what you're doing?
Participant 6:	18:28	No.
Researcher:	18:30	No?
Participant 6:	18:30	No.
Researcher:	18:31	No?
Participant 3:	18:31	Maybe.
Researcher:	18:31	Maybe?
Participant 2:	18:32	I probably wouldn't even do D&T if I had the option to re select.
Researcher:	18:35	Okay. That's interesting.
Participant 5:	18:37	Yes.
Researcher:	18:37	Yes?
Participant 4:	18:37	I wouldn't do a language.
Researcher:	18:40	Yes or no?
Participant 4:	18:40	I would not.
Researcher:	18:41	You wouldn't. That's interesting. What would you like to see more of in the subject?
Participant 4:	18:45	Being unique with your own ideas.
Participant 6:	18:48	Being unique, being more creative and more hands on kind of tasks.
Participant 2:	18:52	Creative freedom within the design process and more strict boundaries when you're designing things.
Participant 3:	18:58	Just generally, yeah. More flowing ideas, like if you're really inspired by this one thing you saw, you being able to talk to the

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		teacher, and say, "Hey, can I do something kind of inspired by this?"
Participant 4:	19:09	Yeah. I would probably say a similar idea, because currently we're doing, we're making these boxes-
Participant 6:	19:18	Animal boxes.
Participant 4:	19:19	... Animal wildlife boxes, and we're really restricted. We only have one-
Participant 2:	19:24	Yeah, you have to do a specific plan.
Participant 4:	19:26	... Yeah, a specific plan. Everything's sort of set out for you. And I think that takes away a bit of the critical thinking. I'm fine with everyone flowing ideas off each other, discussing how to make it, but maybe it's a bit restrictive, or maybe there's another way to do it. It restricts your creativity a bit.
Participant 2:	19:46	With that assignment, they kind of teased us. They let us design the box, but we had to follow a blueprint and build it off that.
Participant 3:	19:55	I get why they made us do that. So, for the safety of the animals that we're going to give the boxes to. And so, the animals... but still, they did tease us a bit by letting us design whatever we wanted. And then being like, "This is the blueprint."
Researcher:	20:10	Does anyone have any final comments they'd like to make?
Participant 3:	20:13	I don't like D&T.
Researcher:	20:13	That's all right. I'm not going to pass that on. You can speak freely.
Participant 3:	20:18	Okay, good.
Participant 4:	20:18	I like it, but I would like more freedom in the workshop. I understand there's safety concerns, but sometimes it's just a bit frustrating, when last year we would use more tools and disc sanders and everything, and now the teachers have to operate the saws, and they engage us more. But obviously, they're safety concerns, so what can you do?
Participant 2:	20:43	Yeah. Last year, we were actually able to use a couple more tools than we have been able. I'm not sure if we needed to use them with this task, but yeah, we were able to use more tools, I'm pretty sure, last year than we were this year. And also they

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		explained the tools for like 30 minutes. And then we have 10 minutes to actually start building things.
Participant 6:	21:02	It's still a good subject. But even without COVID, I'm still pretty sure we would've done the same amount of research and stuff. And the workshop, it's more restricted than it was in previous years, actually. Like last year, you could almost use grab the tool. You still had to get permission from the teacher, and there were still rules, but you could almost just get the stuff you need and put on the safety gear, and then the teacher would let you go ahead. But this year, the teacher, she's keeping constant eye. And if you're doing this single thing incorrectly, they just get really mad about it.
Participant 3:	21:42	Well, I think that's for safety. This is kind of dangerous subject, because you can easily lose fingers. So, they're definitely trying to keep us safe, but I feel like they're trying to keep us too safe in a certain way. Of course I don't want students to die or accidentally amputate their own fingers, but I think that they aren't really preparing us for year 11 and 12, when we can use most of the machinery ourselves with a little less supervision.
Participant 5:	22:14	Keeping us so safe that we don't really know what to do.
Participant 3:	22:15	Yeah. Yeah.
Participant 5:	22:16	They need to allow us to take more risks.
Researcher:	22:19	Okay. You'd like some more risk taking?
Participant 3:	22:20	And especially in designs, risking in designs and things, although we need more opportunity to create a risky design that might not work, but if it did, it would be really cool.
Researcher:	22:32	Oh, so what you're talking about is not the risk in terms of, "I need to use this really dangerous machine to do this," but the risk is that, "My design just won't work?"
Participant 3:	22:39	Yeah. Also, we just wouldn't want to use really dangerous machinery that could easily cut off our fingers.
Participant 5:	22:50	Like a disc sander or something.
Participant 3:	22:51	Yeah. Just let us use things. [crosstalk 00:22:55].
Participant 5:	22:54	The CNC router had a year nine [crosstalk 00:22:55]

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Participant 3:	22:55	I know, right. CNC router [crosstalk 00:22:56]
Participant 6:	22:55	How could you even get hurt by that, though? Unless it was thrown-
Researcher:	22:56	So, you can use it, or you can't use it?
Participant 6:	22:56	We can't.
Participant 3:	23:05	We can't use it. And it's so cool.
Participant 6:	23:06	But there's a massive protective wall around, unless you throw yourself with someone into it, how are you going to get hurt on that?
Participant 4:	23:13	And I think it's at the point where sometimes, this restriction restricts my design. I'd be fine if it's like, "Oh, you're not allowed to use the machine." Oh, it doesn't affect my design at all, because I was never going to use it in the first place. But when we're not allowed to use things that the teachers just have to do instead of us, it's just like, "Oh, I wanted to cut something. I wanted to do it in my design."
Participant 2:	23:34	Yeah. "I felt like chopping something up today."
Participant 4:	23:38	Yeah. And it would just be so easy. It affects my design. So, I think there's a fine line between safety, but also letting the students have a bit of freedom.
Participant 5:	23:53	Yeah, and sort of also asking us be really creative and really push the creative boundaries outside of the box, but then they're restricting us with what we can use, the materials we can use, the way we can use it. The lessons we have to do it in, the time limits, so it's really hard to sort of branch out and be more creative with those sort of restrictions around everything. Even with the safety rules-

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researcher:	00:00	We're now recording with a bunch of six, year nine French students. Looking back at your concept maps, looking at what you've now done, are there any keywords for you, and a keyword meaning just like a single word, or maybe two words together that stand out? How would you walk out of this room and tell someone what you did in terms of keywords, in terms of the concepts that you identified?
participant:	00:21	ATAR.
participant:	00:23	In terms of, including ATAR, you've also got occupation.
participant:	00:27	Beneficial.
researcher:	00:29	ATAR, occupation, beneficial.
participant:	00:32	Social life.
participant:	00:34	That's a language and a culture.
researcher:	00:37	Did anyone have these concepts in their head when they were thinking about making the decision to do this subject?
participant:	00:43	Yeah.
researcher:	00:44	Yeah. How so?
participant:	00:47	Well, the ATAR points, that was one of the things that influenced me to choose French.
researcher:	00:53	Because it scales well?
participant:	00:54	Yeah.
participant:	00:56	Knowing a language can help you in terms of what occupation you want to choose and where you might end up living at the end of that occupation. For example, working in international affairs.
researcher:	01:12	What kind of international affairs?
participant:	01:14	Things like foreign affairs, working in embassies, other things like defense force.
researcher:	01:19	Which of the concepts did you think were difficult to draw?

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participant:	01:23	Probably culture, because it's so widespread. You can't really memorize it into a drawing.
researcher:	01:30	What are the key things that stand out for you with French culture?
participant:	01:35	Probably the food, the [inaudible 00:01:36], the cuisines.
researcher:	01:39	The [inaudible 00:01:40]?
participant:	01:39	The art within the culture.
researcher:	01:41	And any particular style of art?
participant:	01:48	Not particularly. And as well, not just visual art, but also performing arts and stuff like that.
researcher:	01:50	Oh, okay. Yeah, culture is often a very difficult thing to even describe, to talk about. You say, "Oh, they're different. You wouldn't get it. It's, it's a cultural thing." Is that the kind of thing you pick up with French as well? Have you come across any areas in the subject that you weren't expecting?
participant:	02:08	I think just the vocab, because there's just a large, wide variety of vocab, and you just have to remember, and just... Yeah, just learn all the vocab and remember it.
participant:	02:19	And the female and male identification of nouns.
participant:	02:27	Also, the way the verbs are. There's a lot more conjugation in terms of informal and formal. The verbs and the way it's said.
researcher:	02:36	When we think about studying a language and its wider implications, we've talked a little bit about it in terms of getting jobs with, say, international affairs or international development, how do you think that that's going to influence the way you think about other cultures that aren't French or as you mix with other... or as you cross the borders, say, and you come up against other countries and other cultures, how do you think that learning the language influences the way you respond to that?
participant:	03:09	If you learn the language, it means that you gain more of an understanding on how the cultures work and how everything kind of resides in their beliefs. It also helps you understand the way they kind of treat their way of life.

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researcher:	03:34	Do you think knowing a European language helps you to relate to people from non-European cultures? Is it a clash of cultures or is it a meeting of cultures which enables you to better understand other people?
participant:	03:47	It's a bit mixed. Sometimes you understand the culture more than, say, a non-European one, but then other times you may feel like it's got its similarities.
researcher:	04:03	If you could have more in the subject, what would that be?
participant:	04:07	Physical activity like first hand, hands-on.
participant:	04:13	Like excursions [crosstalk 00:04:12].
researcher:	04:14	Hands-on activities?
participant:	04:15	Yeah.
researcher:	04:15	What do you think that might look like?
participant:	04:17	Well, in terms of hands-on, that doesn't really mean arts and crafts. It can mean going to different places. In terms of COVID, that's not quite the case right now, but going out and meeting other students from different schools that do-
participant:	04:31	Exchange.
participant:	04:31	... French exchange, going places that-
participant:	04:33	You could go to French restaurants.
participant:	04:35	Yeah.
participant:	04:36	Maybe even try cooking a [crosstalk 00:04:38].
participant:	04:40	Or bringing them here, even.
participant:	04:40	If we can more about the French history rather than just the language itself, because at the moment we're only just learning about the language and how to speak it rather than the actual culture itself. Yeah. In terms of the way they colonized, but also in terms of, for example, the Arc De Triomphe was built once the Germans had been pushed out of Paris, in terms of world war one, world war two and successes, defeats, that kind of thing. The way they've acted throughout the world.

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researcher:	05:22	So history, hands-on activities, meeting with people, interacting with other French students. Do you think that in a non-COVID world, or when this subsides, maybe next year, that you might have that chance? Would you like to approach... Do you know other schools around here that do French?
participant:	05:36	I think [inaudible 00:05:38] in Canberra they do French so...
participant:	05:41	[inaudible 00:05:40].
participant:	05:41	And they do it actively.
participant:	05:42	Yeah. They do [crosstalk 00:05:43].
researcher:	05:43	Do you think that's because of the fact that it's the nation's capital? Does that have anything to do with it?
participant:	05:48	Possibly, because you get a lot of international students here for reasons such as parents in Paris or politicians or ambassadors.

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Researcher:	00:01	With us today, we have five languages students, four from year 10, one from year nine and the languages vary, I think. So, Tamil?
P3 Tamil:	00:12	Tamil.
P2 Indonesian:	00:12	Indonesian.
Researcher:	00:12	Indonesian.
P4 Indonesian:	00:13	Indonesian.
P5 Indonesian:	00:13	Indonesian.
P6 French:	00:16	French.
Researcher:	00:17	And one French student, terrific. So what we looked at today was producing concept maps using some propositions that were pulled out of concept maps produced by technology students and I've asked you to reconceptualize your subject with those things in mind and to try and see whether those things have any impact on the way that you conceptualize your subject. The answer could be yes, no, maybe, and anywhere in between. So I guess the first question that I'm going to open up is, when you looked at those propositions and then thought about your subject, did they make any impact on you at all? Was there anything that jumped out at you? Was there a connection that you made? Was there any kind of crossover that you saw? And I'll just throw it open and remember, speak boldly.
P3 Tamil:	01:18	I think that the solving and creativity elements kind of stood out to me, and especially a main link I found between solving and creativity is in the translation between languages because understanding or bilingual understand two languages, being able to link and translate them without the meaning being lost in translation and just using solving skills and creativity, both of them to just increase that understanding and to make a meaningful sentence, you translated it.
Researcher:	01:54	So let me see if I get this straight or if I understand this correctly, the notion of having a linguistic barrier is a problem for you to solve.
P3 Tamil:	02:07	Yeah.
Researcher:	02:08	Is that what you're trying to say?

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P3 Tamil:	02:08	Yeah, correct.
Researcher:	02:08	Okay.
P2 Indonesian:	02:15	I think for me it was more learning new skills or improving old skills. What I found was that most of the things I looked at always led back to learning the skills. And so when I was asking questions about how it works or how is it structured, I asked those questions in order to build my skill or to learn new skills or when solving stuff, how we learn from mistakes or what Layla said, anything lost in translation, how we solve that. It kind of always leads back to building my skills in Indonesian and, well, overall, and then trying to improve my fluency in Indonesian.
Researcher:	02:55	What kind of skills in Indonesian, can you elaborate on that? Can you be specific about those?
P2 Indonesian:	03:01	I mean, I guess it's more like learning new words or practicing specific phrases and learning the word tenses or learning how Indonesian is structured, because it's different from most languages. And then it's just all in order to improve.
Researcher:	03:24	Just going on from that, would you see a skill as being the way that you suddenly find yourself in an interaction with an Indonesian-speaking person or if you were to be in Indonesian and find yourself in a situation, is that a skill as well? As in learning how to handle that.
P2 Indonesian:	03:44	I guess that could be considered a skill. I think I was more thinking about improving the language itself than improving my knowledge in the language or culture. And I don't know, I wasn't really thinking more about situations in which I'd have to use those skills.
Researcher:	04:05	Okay, great.
P4 Indonesian:	04:05	I think for me it was improving skills and creativity because I like creative things and I like things like poetry and creative writing, but to do that, I would need to improve my skills because in this language, how you speak is different to how you write it, you need to write more formally, and there's a correct way to write it. So learning how to write it and then going to poetry and creative writing would... I'd like that, that'd be cool.
Researcher:	04:31	Are you as creative in English as you are in the other language?

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P4 Indonesian:	04:37	I'm probably more creative in English just because I have a good understanding of how the language works and creative writing and stuff.
Researcher:	04:44	And you'd like to have a similar skill of creativity or a similar ability to be creative, let me put it that way, in the other language?
P4 Indonesian:	04:50	Yeah.
Researcher:	04:51	Is that something that drives you to want to know the other language?
P4 Indonesian:	04:54	Basically, yeah.
Researcher:	04:55	So that intrinsic motivation within you to be creative or expressive in poetry, I think you said?
P4 Indonesian:	05:03	Yeah.
Researcher:	05:04	That's a main driver, a main motivator for you?
P4 Indonesian:	05:06	Yeah.
Researcher:	05:06	Interesting.
P6 French:	05:12	For me, I think the ask one, asking questions sort of went into every single one because for me, I was just thinking more of the culture than actually the learning skills and everything because for me, the language sort of connects to everything, not just learning the words and stuff.
P5 Indonesian:	05:39	I feel like for me it was more about connection and connection between countries and creating connections between the languages in some way, like how that can improve your knowledge of the language and relations between different countries politically.
Researcher:	05:56	Were there any of those propositions that you looked at where you thought, that makes no sense to me, or not necessarily no sense, but there's no linkage there for me at all.
P2 Indonesian:	06:07	For me, I found it hard to link creativity that aspect into Indonesian, because I'm not a very creative person. I'm far more logical, and so I wasn't really sure how to kind of incorporate that in there so there's nothing in there about creativity for me.

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Researcher:	06:29	Do your other subjects that you do here at the school speak more to your logical mind?
P2 Indonesian:	06:33	Yep.
Researcher:	06:33	And which ones are they?
P2 Indonesian:	06:35	I guess that's more science and commerce I guess, as well. And what else? I guess a little bit of humanities.
Researcher:	06:46	Okay, interesting. A logical connection. Science, commerce, humanities, and language. And you see a common logical thread through those?
P2 Indonesian:	06:53	I mean, I don't really link them together, but those are just kind of things that I prefer because I don't really like using creativity. And then in Indonesian, I mean, there is some aspects of creativity within it, but I think I'm more logical.
Researcher:	07:07	Okay. Let me try this then, I'm going to give you the questions that I would give to the technology students. Have a look through these propositions, because that's what I've managed to glean from your original concept maps. Has everyone got one?
P2 Indonesian:	07:32	I missed one.
Researcher:	07:34	Oh, you missed one. One of the strongest linkages there was understanding, which really surprised me. So to deepen understanding, to gain understanding. And then the second one was, I think to know, I think, is that right?
P2 Indonesian:	07:54	To learn better.
Researcher:	07:55	Yeah. So there was a strong linkage with learning and knowing better and improvement. Does that surprise you?
P6 French:	08:04	No, because language is really, it's got so many benefits, because they've both got creative aspects, but just in different ways. Because with language, you have to use the words that you have learnt to make a sentence, because a lot of the time you don't learn all the words that you would prefer to use in a sentence so you sort of have to maneuver your way around using the words that you know to make sense of it. Whilst in other subjects like DT, you sort of have to use the other part of your creative mind in which to... You make something that's new, that's not been brought up to you before. Whilst in

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		language, you have to use the ones that have been brought up to you before, the ideas that have been brought to you before.
P5 Indonesian:	08:58	Yeah. With the creative subjects like English and art and DT, there's more of an open playing field in which there's so many ideas that you could come up with but in Indonesian and other languages, you've kind of got the smaller playing field with words you've got to learn and you've kind of got to just focus on that area first before you really expand.
Researcher:	09:25	Why do you think, and this might seem like a strange question, why do you think understanding came out as a key thing?
P2 Indonesian:	09:34	Because everything requires understanding, doesn't it?
Researcher:	09:37	Well, sure, but at school we talk about teaching and learning and in order to learn something, I guess you need to understand it, but the expectation that I had, perhaps somewhat naively was, I was expecting the value to come out in terms of I want to be able to speak the language, I want to be able to travel. Well, there was a lot about travel as well. But I was expecting a lot more about the mechanics of the language, like reading, writing, grammar structure, speaking competency, fluency, that sort of thing.
	10:13	Whereas one of the stronger themes was understanding, in other words, I want to understand the culture, I want to understand the structure, I want to understand the language. Is there a particular motivation that you think that's driving that, or does that result just perhaps seem a little bit random to you?
P2 Indonesian:	10:31	I think it's just natural curiosity because you can't really learn a language without understanding it, that's not possible. And so I guess by also understanding its culture or how it works, I think it's just something that we want to do. I don't really know why, I think it is kind of random.
Researcher:	10:52	So if I was to just put a vocabulary up on the wall... Let's just dig down into this a little bit deeper in the few minutes that we have. If I was to put a vocabulary on the wall and say, these are the words, and this is how a subject works and so in English you've got subject, object, verb, and in other languages, those things kind of move around a little bit, and the order changes, and this is how you put the words together, and this is how you would then say that, and effectively we'll translate this from this, and this is how you do that in the other language, is that

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not enough? So that would be more like a memory-based learning. Okay, I can do it, but is that enough?

P2 Indonesian: 11:31 I think it's because understanding comes more with the grammar, I think. And it's not more about just knowing, it's about understanding so then you can... Because with language, it has to be fluid and you have to be able to craft it your own way and when you just know the things, you know a few words, you know some things, but with grammar and other things, you have to understand it to actually be able to effectively use it.

P5 Indonesian: 12:04 And in English, you just know the language, you don't really understand it. You know it and things just come naturally to you so you don't really dive deeper into looking... On a daily basis you don't really dive deeper into looking into that language and why it works like that, and stuff like that, you'll just order things correctly just because you know how to. But if you learn a language, then you have to actually understand why you have to order it like that and how to order it and stuff like that.

Researcher: 12:35 So do you think that knowing, say something like English as your native language, that that just kind of generates a bit of a complacency or just a shallowness in the way that you understand that level of communication?

P5 Indonesian: 12:49 Yeah, generally you just do it because you know how to do it, and you don't really have to think any deeper than that. But when you are learning a language, it stretches your brain a bit and you have to work out how to form that sentence.

Researcher: 13:02 Do you see that as a challenge, that stress on your brain? Is that an enjoyable challenge?

P2 Indonesian: 13:06 Yeah.

P5 Indonesian: 13:07 Yeah.

Researcher: 13:07 Is it the same sort of enjoyable challenge as say something like another subject?

P2 Indonesian: 13:12 I think with language it's different because it's a whole new sort of world when you go into the classroom. You sort of experience a different culture and you get to experience the way that they express themselves and the different mannerisms and everything and you sort of want to really, really learn that because it's just a part of... It's like English for us, it's a part of someone's daily lives, and they don't think too much about

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		using the language. But whereas other things, like for math and English, it's more of a thing that everyone has to learn. But then with other subjects like electives and everything, it seems a bit more tailored towards what you want and all that.
Researcher:	14:01	So we've only got a couple of minutes left. I'll just get a quick reflection from each of you, can be one word. When you look at what you've produced, does it look any different? Do you think it's been slightly modified? Is there any change? Yes, no, maybe, a little bit?
P2 Indonesian:	14:22	You go first.
P4 Indonesian:	14:24	Yeah. For me, it's kind of. Because in my first one, I didn't really think too much about the creative aspect of it, but now after seeing what technology students brought up, I was like, oh yeah, I like that idea.
Researcher:	14:36	Great. Yeah, good.
P2 Indonesian:	14:37	I think for me, it's quite a big change and I think I've been influenced by what they've been writing, because I think in the last one, I talked a lot about understanding, but now I'm talking more about learning the skills, which doesn't... I think, yeah, I've been influenced by what the technology students have written.
Researcher:	14:55	Right, okay.
P3 Tamil:	14:57	I think I looked a lot closer at the solving and creativity aspects, because before I just talked about understanding and how that can lead to opportunities and like I talked about a bit about connections, but I didn't really think about the solving and creative aspects and how that links together, and then how that links back to the understanding of the language.
Researcher:	15:19	Terrific.
P5 Indonesian:	15:20	My old one didn't really have many connections between the things, and it was more streamlined, but now it's sort of more connections and things might have multiple things on them, because a lot of things can be applied to other things in Indonesian.
Researcher:	15:34	Great.

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P6 French:	15:36	For me, I don't really know. It's more that it's like the grammar and stuff and the way the language works was... I elaborated more on that than my last one.
Researcher:	15:50	Terrific. Okay. Well, we're just about out of time. No one has any final comments or questions. Okay. So it was Tamil, Indonesian, Indonesian, Indonesian and French? Okay. So you can leave your documents exactly as they are, I'll collect them because I'm just going to make a little note on them. And make sure you pick out your pencils or pens, which whichever were yours. I hope you can identify them, it's not a big deal.
	16:20	But once again, thank you so much for your participation. You've produced some great responses and we really appreciate the contribution that you've made and the university certainly appreciates the contributions as well. And thank you also to your teacher for supervising for an hour.
P7 Teacher:	16:35	Thank you. I enjoyed listening to the-
Researcher:	16:43	Terrific. So I'll only be in here for another five minutes, and then I'll check out at the office. I've just got to collect a few things.
P7 Teacher:	16:51	Yeah, of course.
Researcher:	16:52	Okay. All right, well thanks very much.
P7 Teacher:	16:59	All good?
Researcher:	17:00	Yeah, that was fantastic.
P7 Teacher:	17:01	Good.
Researcher:	17:01	Thank you so much.
P7 Teacher:	17:02	No, that's all right.
Researcher:	17:03	It was really interesting. It was really interesting to see the way that they made connections with how other people think and then pulled that back into their own experience.
P7 Teacher:	17:10	Yeah, yeah, that's right.
Researcher:	17:10	I didn't expect that.
P7 Teacher:	17:10	You didn't expect that?

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Researcher: 17:10 No.

P7 Teacher: 17:15 Yeah, yeah. Oh, that's good findings then.

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Researcher:	00:01	So in this interview we have three, year 10, design technology students and four-
Participant 2:	00:06	Four
Researcher:	00:08	Sorry?
Participant 2:	00:08	Four year 10s.
Researcher:	00:09	Oh, sorry. Four, year 10. And three, year 9. Good pickup. We've just done some concept map drawings after looking at the propositions presented by languages students. My first question to you is, and feel free to speak out and speak boldly so that the machine can hear you, were there any concepts... Sorry. Were there any propositions that you looked at which you connected with? And felt made some kind of... Or had some kind of an influence on what you felt that you needed to represent graphically? And I'll just throw that open. Anyone can jump in.
Participant 4:	00:49	The intelligence across subjects. I thought maybe, DT could give you time management research skills and writing skills, especially in the theory lessons.
Researcher:	00:59	Oh, that's interesting. Yeah. Great.
Participant 2:	01:06	I think with the understanding of the propositions. Like DT or technology, it gives you a greater understanding of a broader subject. So it has so many different sort of things within technology that you can gain understanding greater across the whole of technology.
Researcher:	01:29	So the whole of technology, as opposed to, all of your other subjects?
Participant 2:	01:33	Yeah, yeah, yeah.
Researcher:	01:34	So, within technology?
Participant 2:	01:35	Yeah.
Researcher:	01:36	Yeah.
Participant 3:	01:38	The both sides of the brain one. Because DT is very... It's very creative, but it's also very structured.
Researcher:	01:49	And do you think it needs to be structured?

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Participant 3:	01:51	I mean, there is a process. And I trust the process because it works, but it doesn't always need to be structured. Because sometimes it can be pretty fluid and creative.
Researcher:	02:03	Do you mean something... When you say process, do you mean what we might call the design process?
Participant 3:	02:08	Yes.
Researcher:	02:11	And can you summarize what you think the design process is? Can you put it into a couple of keywords?
Participant 3:	02:19	It's just a matter of doing something and designing something that helps it be the best product possible.
Participant 4:	02:29	I would add on to that and say, the design process, sorry, is about finding your problem, defining it, and then finding a solution to it.
Researcher:	02:45	Any other propositions that stood out to you?
Participant 2:	02:49	I think the learning one. And benefiting from your learning abilities. Because in design technology, it has heaps of branches and if you really put into the learning, then you can gain benefits, for just in general, and in life.
Researcher:	03:12	So when you say the learning, are you... Let's try and find out exactly what you mean by that. And we might not get a specific answer. But I'm guessing, and correct me if I'm wrong, when we talk about learning in design technology, are you talking about certain fundamental things that you need to know in order to be able to transfer those skills to many different applications?
Participant 2:	03:38	Yeah. So, I mean, sort of the practical component and just general life. So whether it's making a product or going through the design process and learning process of how to properly build something. And things like that.
Researcher:	04:01	As in just being generally useful for life.
Participant 2:	04:03	Yeah. The things you'll learn in DT will generally convert over to like, you can use it in life. And later in life, et cetera.
Researcher:	04:15	Yeah. Were there any propositions there, one or two or maybe several that where, you thought, "Oh, that's weird. Can't really see any relationship there."

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Participant 4:	04:30	Oh, maybe the memory skills one. I don't really think that applies to design technology that much.
Participant 3:	04:39	The connection one. That doesn't [inaudible 00:04:43]. Design tech isn't really as connective as languages would be.
Researcher:	04:51	Yeah. I guess the memory one's interesting too, isn't it? Because we have a lot of technical specifications that we need to remember, but usually that's the kind of thing that you might look up. For example, if you're tapping a thread into metal and you go, oh, what's the diameter drill bit that I need to use to tap this product? Oh, I'll look that up in a table. And that's generally what we talk about in terms of making use of reference materials and things like that. Was there anything that anyone thought, "You know what, I think I might consider this as a result of having looked at those." Does anyone think that anything new appeared that perhaps they don't remember drawing last time?
Participant 4:	05:36	Oh, I think the fun to learn one, I kind of thought, at least definitely in the workshop, allows me to be more creative. Because it's enjoyable. And also maybe, it makes it easier to learn, because it's enjoyable to learn.
Researcher:	05:52	What do you think is driving that? Can you go a little bit deeper? Where do you think the motivation to have fun is coming from?
Participant 4:	05:59	I guess I just enjoy the subject. The workshop especially.
Researcher:	06:06	Is it a different type of fun to, say, going outside and kicking a ball or playing your favorite sport?
Participant 4:	06:14	Yeah. I would say it's a bit different. I don't really know how to explain it. It's just enjoyable to learn in DT, I guess.
Participant 5:	06:25	You are not getting talked at by the teacher. You're actually going out of your way and making something.
Participant 2:	06:34	I think if you're enjoying what you're doing as well, you're more willing to try harder and put more effort into it. Whereas, for something like another subject that you don't gain as much enjoyment or have as much fun doing, you're not going to put as much effort in. Or you're not going to be willing to try as hard as what you might if you're enjoying the subject
Researcher:	06:57	Because it's a bit more of a grind.

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Participant 2:	06:59	Yeah.
Researcher:	06:59	So it's something that you have to endure rather than where you can just feel free to be who you are.
Participant 2:	07:05	Yeah, correct.
Participant 3:	07:06	And DT is kind of different from other subjects, because time sort of flies by when you're in the workshop. It feels like 15 minutes has passed, but it's actually been 40 minutes or something like that. In all the other subjects you can feel the seconds ticking by.
Researcher:	07:25	Which subjects might they be?
Participant 2:	07:26	Maths.
Participant 3:	07:28	Maths, yeah.
Researcher:	07:30	Oh, that's interesting. Why do you think that is in maths? Is that a matter of interest or is there this weird kind of black hole that you've got to go through before you can get to the other side, where it all just seems to make sense? What do you think is driving that?
Participant 4:	07:48	I'm just speaking for myself here, but when I'm doing maths and NPP, I find it goes fast. I think maybe, because I enjoy it. It feels like it goes fast.
Researcher:	08:00	Yeah.
Participant 2:	08:01	Yeah. That comes back to the enjoyment part. When you're enjoying something. Time flies when you're having fun.
Researcher:	08:07	Sure. Well, it's the old saying, right?
Participant 2:	08:09	Yeah.
Researcher:	08:09	Did you want to make a comment?
Participant 6:	08:10	Oh, well see, math... I like math, personally, it's fun. But most people, I think, they go to the equations and numbers and like, oh, doesn't make sense. But for me, it's like un-jumbling the equation. Getting that [inaudible 00:08:26] or X or something. It's kind of that with DT as well, doing the design process, when you get to that final thing, you're like, the relief.

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Researcher:	08:37	So do you see a vague similarity then between the difficulty of solving a mathematical problem and the solving of a design problem?
Participant 6:	08:46	Yeah. Absolutely.
Researcher:	08:47	So you see a strong link between those two subjects? Interesting.
Participant 2:	08:52	I think the maths... Solving a problem in maths requires a different skill. A different skill set compared to DT. Because DT is more practical and stuff. And that's why people find more enjoyment out of getting to the solution. And then once you get there, like [inaudible 00:09:16]. I'd say that links to the connection part as well. In DT, to find a solution, you need more of a connection to the problem. Whereas, in a mathematical problem, it's more of like... You have a more straight up solution through a formula or something like that. Whereas, with DT, it's more about connecting to what the problem is, why you need to find a solution to the problem. That type of thing.
Participant 6:	09:50	You kind of see that in math as well, though.
Researcher:	09:52	Yeah? How so?
Participant 6:	09:55	Because, see, when you have a huge equation, you have to have a number of properties to solve it. So that's kind of like DT, right? So you have a problem, but you have to apply it in a different way.
Participant 3:	10:07	It's kind of like creative maths.
Participant 6:	10:09	Yeah.
Participant 3:	10:11	It's like, with maths, everything's sort of set out for you. Sometimes you have to work things out. But with DT, there's a problem that you have to create an original answer to.
Researcher:	10:22	Let me give you two examples then. We'll finish with these two examples and see how you go with this. One is something that I've done with some students when I was working as a teacher. And one is a question that I posed to students who are participating in this study, but at another school. Let me start with the first one. When I was working as a teacher. I like maths, but I wouldn't call myself a mathematician. And when I did maths, I did extension maths at school. But I had to work really hard for it. So it didn't come naturally. And I kind of

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		enjoyed it. It was a little bit like climbing the mountains. Really, really hard work, but when you get there, you enjoy the view. Whereas, other people just seem to be able to glide in or parachute in and say, hey, it's fantastic.
Researcher:	11:04	But one day, I realized that there is this elegance in maths and I was exposed to the golden ratio or the golden mean. You might have come across it. And you can actually solve the golden mean through using a quadratic equation to look at a particular type of proportion. And the golden ratio has been used right throughout history in design. And I could go into the history, but it goes back a long, long way. People like Leonardo da Vinci have used it. The Greeks used it when they built their palaces and so forth.
Researcher:	11:41	And that was really interesting to look at, designing and creating, using a mathematical principle as the foundation or as the starting point. Now, what I said to some students last week from another school was, and if I can just sort of use this as a bit of a parallel, I said... Because they were talking about understanding different perspectives in design. I said, "How about this, what if I was to say to you..." Picking on the strongest thing coming from the languages students of understanding. "What if I was to say to you, here's a problem, and as a design student or as a STEM student, what I'd like you to do is, produce a solution that demonstrates that you understand the problem." How would you feel about that?
Participant 4:	12:28	Solve it almost perfectly, I guess.
Researcher:	12:32	Yeah. So what I was trying to get at, was that... I'll give you a bit more backstory. They were expressing that they were kind of getting tired of just problem solve, problem solve. It seemed to be this kind of mechanical thing, just on and on and on. And I said, "Okay, well let's just shift it around a little bit. Let's say that you needed to produce a solution, forget the way you've done it in the past, but produce a solution that shows the end user that you actually understand what the problem is. How would you feel about that?" Now they gave their response. What do you think of that?
Participant 3:	13:11	I guess that's when the design process really comes in. Because the major part of it is empathy and understanding the problem and defining the problem. And basically being in their shoes so you can see how they feel about the problem and what the problem actually is. So I guess that would become a big part of it, if you were solving it that way.

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Researcher:	13:32	Do you think that the notion of understanding could perhaps play a bigger role in the technology experiences that you've had? Yes? No? Maybe somewhere in between?
Participant 6:	13:47	Kind of depends on what area of design that you're talking about. Except for the empathy part. Yeah. You've got the understanding, [inaudible 00:13:56] as a solution part, you got to make your own.
Researcher:	14:01	I've always liked to entertain the idea that, what if calculus... What if there was another way of writing calculus? You know how you can say something in French and you can say something in German and you can say something in English and they all mean the same thing. Well, for example, we use calculus to design airplanes to keep A380s in the air and stop them from crashing. What if you could write that in a different language? What if you could come up with something that wasn't calculus, but achieve the same result. Wouldn't that demonstrate... Or wouldn't that be what an example of, here's a language that really understands this problem. But then you come up with a completely different way of expressing it. Do you think that approach might have some space in the technology subject that you've done?
Participant 6:	14:53	Yes.
Participant 2:	14:54	Yeah.
Researcher:	14:56	Because that's really pushing the boundaries of thinking differently, isn't it?
Participant 2:	14:59	Yeah.
Researcher:	15:02	See, an example that I had with these students from last week was, they said, "Oh, well, we fly drones in the STEM class." And they were a little bit, kind of, bored with it. Which I was really surprised by. They said, "Oh, look, so they made us assemble these drones and we flew them and we ran some simulations. Great." But there wasn't a strong underlying purpose for why they did that. And then one student piped up and said, "Oh yeah, but maybe if we could use those drones to fly water from one place to a remote area where people struggle to have water." And I said, "Yeah, that's interesting." I said, "Do you think that solves the problem, or it understands the problem?" And they said, "Well, I guess it solved it, because they need the water."

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Researcher:	15:48	And I said, "Yeah, but I guess the bigger problem is, why do they live there, and why is there no water there? Why is there no infrastructure that takes the water there? Why do we suddenly have to create this thing that flies it?" Because, obviously, flying water is difficult, because it's heavy. And it sloshes around and it's not good in airplanes. And then they said they sat there and they went, "Oh yeah. Yeah, maybe there's a bigger problem here." And then one student piped in and said, "Yeah, that's interesting, isn't it? Maybe the engineering perspective isn't particularly helpful in that particular case." And that then started this whole other discussion, which I thought was really interesting. So, I guess what I'm trying to suggest here, is that maybe there's room for, as you have suggested as well, just a slightly different way doing. What do you think about that?
Participant 7:	16:43	Provide different perspectives on the problem. Not all problems can be solved the same way.
Researcher:	16:47	Did anyone want to ask any... Just keeping an eye on the time. Did anyone want to ask any final questions or make any final comments? No? You kind of look like it's near the end of the year. Which I totally get, by the way. It's completely understandable. I have a 10-year-old son and I think he was in that state probably about two weeks ago. It's the end of the year. So he's looking forward to doing 10-year-old stuff like, going to the pool and having pizza at school and all that kind of stuff. All those fun things.
Researcher:	17:28	Well, I just really want to thank you again for your contribution and for taking the time to come and speak to me again. I think it's been really great. I just want to encourage you to remember that your input and your participation will make a material difference to the way we think about technology education. Certainly to the way I train technology teachers.
Researcher:	17:48	I've been doing technology teaching for 20 years. And it's a really good... It's a wonderful privilege for me to be able to work with prospective teachers and say, "Hey, listen, let me tell you something. When you get into a classroom with technology students, here's what they want to do. Here's what you think the curriculum might say, and here's what they actually want to do. So why don't we try and think about running classes that work like this?" And usually, those teachers or those students respond pretty well to that. So that they like the hands-on experience. And talking to you just provides more of that experience that we can then share. Of course, remember, it's all

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		completely anonymous. No one knows who you are. But you've made a wonderful contribution and I thank you for your time.
Participant 2:	18:35	Thank you.
Participant 7:	18:35	Thank you.
Participant 6:	18:35	Thanks.
Researcher:	18:36	So you can just leave everything as it is. I'll just make a couple of notes on people's drawings. And then I'll be in touch with your teachers as well. And you never know, I might come back to talk to them about how they can change things up a bit.
Participant 3:	18:49	Well, thank you.
Participant 4:	18:51	Thanks.
Participant 2:	18:51	Thank you.
Researcher:	18:51	Okay.

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Researcher:	00:03	Okay. First of all, we have one, two, three, four, five, six year nine French students and one year 10 French student and one Russian student in year 10, who is with us via Zoom. When you had a look at the propositions or the meaningful statements that were created by the technology students, what was your initial reaction to that and did you think there was any connection at all? And I'll just throw it open. Feel free to jump in.
Participant 2:	00:36	Ask the question again.
Researcher:	00:43	Okay. So when you saw the propositions, so when I look at the propositions and I go, oh, okay, so students in technology classes drew things that boiled down to these five things. Did that make any connection with you at all with respect to the subject that you are studying?
Participant 3:	01:00	You can learn new different skills in French with the vocabulary, writing, listening, speaking.
Researcher:	01:10	So you see the actual speaking and the writing as a skill?
Participant 3:	01:14	Yeah.
Researcher:	01:17	Mr. Lang, could we perhaps just close the door? Just might get rid of a bit of background noise. How do you see that skill... Or how do you see yourself using that skill? What kind of things do you... Apart from, well, it's kind of an obvious question, but how do you see yourself using that skill or doing that skill? And anyone, you can jump in, by the way.
Participant 2:	01:48	I guess in an occupational point of view, if you knew the language and you could write and speak it fluently. For example, if you're working overseas in a French-speaking country, you'd be able to understand and work with those citizens. It would work a bit better and it would make things easier.
Researcher:	02:15	So what do you think is the underlying motivation that drives the need to develop that skill?
Participant 4:	02:23	I mean, it can create new opportunities for you and improve in that sense.
Researcher:	02:29	So new opportunities aside from all of the other things that you might learn at school?

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Participant 4:	02:35	Yeah, I guess because you can intertwine it, I guess, with other subjects. So for instance, if you say work overseas in some sort of maybe humanities-based field, and it's a French-speaking country, you can link those together and by having the knowledge of French, that could open up new doors in a sense.
Researcher:	02:58	That's interesting. When you talk about perhaps working in another country, you live arguably in what we might call... Okay, it's a major Australian city, but arguably it's regional. It's not like a metropolis like Sydney or Melbourne. What was it that made you think beyond this city to think about working outside in another country? How did you get there?
Participant 4:	03:23	Well, I guess within Canberra, at least as an area, it's not particularly like... There's not a lot of... How do I word this right? Okay. There isn't a lot of opportunity, I guess, because of the small population. And there isn't as much of, from what I'm aware, there isn't as much as the [inaudible 00:03:50] French as a culture and a language. So I guess if one has an interest in that area, they would probably have to work in some sort of other area outside of Canberra.
Researcher:	04:06	So this is a little bit like a stepping out opportunity.
Participant 4:	04:09	Yeah.
Researcher:	04:10	So you could get an education here, arguably you could go to university here in Canberra and you could become a professional here in Canberra in a limited variety of professions. But this is more than that. And I'm just trying to paraphrase what I think you mean. So please correct me if I'm wrong, but this is an opportunity for you to do those things and step out somewhere else.
Participant 4:	04:32	Yeah.
Researcher:	04:33	Okay. Interesting. Anybody else?
Participant 5:	04:43	I think in relationship being creative and problem-solving, learning a new language opens up a different way of thinking and a different perspective on how you look at different things.
Researcher:	05:00	So when you say different way of thinking... I mean, I speak another language as well, and I think I understand where you're coming from. Is that about, when we say different way of thinking, does that go right across the board or is it about relationships? Is it about the world? Is it about how we should

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		build a culture, how we should build cities, build communities? Can you be more specific?
Participant 5:	05:27	I feel like it's everything in general and learning about a new culture as well. Understanding the food, the country traditions and places and stuff, and getting to know the problems that are around the world as well. You can understand those in a different way and you can think of more solutions to those problems.
Researcher:	05:55	Okay. So language as a pathway to problem-solving.
Participant 5:	05:58	Mm-hmm.
Researcher:	05:59	Interesting. Were there any that stood out to people where you just go, no, there's no connection for me here. None whatsoever. So I can see some shaking heads, but that's kind of hard to transcribe. So there were no propositions created by the technology students where you'd say, that has absolutely no influence on my thinking about the subject that I'm doing, and that is languages?
Participant 6:	06:39	No, I feel like each one of them relates to language in some way and I guess some to different extents to others.
Researcher:	06:49	Okay. That's interesting. When you think about those propositions and perhaps try to remember back to what you did last time and looking at what you've done now, it might be hard for you to kind of remember what you did last time. Does anything stand out in the drawn response that you've given where you look at that and go, oh, I don't think I've thought about that last time. Is there anything else that you have considered that has stood out for you? Anything obvious to you? And it's important to remember, just while you're thinking about that, this is not a situation where I look at what you've done today and what you did eight weeks ago, and compare those two. What I'm looking at is a pool of responses over here, and then the pool of responses eight weeks later. So I'm not comparing your work to your work, I'm just comparing then and now, generally in terms of languages and technology. So is there anything that you've drawn now or considered today, which you might not have considered before?
Participant 7:	07:56	I think helping other subjects like English about different writing in a different language, it can help you think of how to do that in a different way.

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Researcher:	08:06	Okay. There seems to be a theme emerging about different, as in seeing things differently, doing things differently, thinking differently. Why do you think that difference is valuable?
Participant 8:	08:27	Well, I guess everyone gets something different out of different things, to be honest. And say, this just one example, but people pursue hands-on learning or in class learning differently, and so one may be more fruitful than the other. And the people that it concerns, like the teachers or something, that knowledge is important to them to grow their subject and to find out what's useful and what's not.
Researcher:	09:05	Do you think it might be as simple as boredom? We like different because we get bored.
Participant 6:	09:14	Yeah.
Participant 8:	09:14	Yeah.
Researcher:	09:16	Yeah. Do you get bored?
Participant 6:	09:18	Yeah.
Participant 8:	09:18	Yeah.
Participant 2:	09:19	Like 90% of the day.
Researcher:	09:22	90% of the day. Okay. So you'd like to have perhaps, and I'm just offering a suggestion here, it's not so much a question, but a suggestion that you can respond to. Perhaps a little bit more difference in your school day would help?
Group:	09:35	Yeah.
Researcher:	09:37	Okay. That's interesting. So it looks like then, rather than just looking for a different subject, you're almost looking for a different world as in, gee, what do they do on that part of the planet?
Group:	09:49	Yeah.
Researcher:	09:50	Look, I can understand that because I've traveled back to Germany several times, that's where my cultural background comes from. And one of the really refreshing things when you get there, and I think this is why languages has this to offer, is just by being there, you look around and you go, this is really different. Now, the funny thing about that is you look on the...

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		Let's take a really obvious technology thing that everybody knows and relies on, like cars, kind of boring. I'm not suggesting you need to be a car enthusiast, but everyone uses them and needs them. When you go to another country, well guess what? All the major car brands are there, and you just look around, you go, okay, but somehow when you look around a little bit wider, you realize that the entire environment is somehow different. And that can be very inspiring and almost rejuvenating. Do you think that the essence of what makes you want that in your subject could be transferred into another subject, technology or otherwise?
Participant 2:	11:00	I guess if there was more out of school activities. Due to COVID, that's a bit hard. But in the sense that if you went out after the school, effectively do a lot more excursions, even if it's just based on a topic. For example, in previous schools, we've gone to French restaurants or French cooking classes, or mainly due to COVID we're not doing that. So not add more variety to things.
Researcher:	11:34	Okay. So it's not necessarily just about knowing and understanding the difference, but experiencing and doing the difference as well.
Participant 2:	11:41	Yes.
Researcher:	11:42	So you need to have that connection. Okay. That's interesting. I'm just keeping an eye on the time here. Does anyone have any final comments or questions that they want to ask about this particular experience and where this might lead or any other comments you might like to offer in response to some of the things that you've seen from the other students?
	12:19	No? Okay. Well, what I'd like to do is, I'd like to thank you very much for your participation. It's been really excellent and I'm very grateful to have been welcomed back for a second time. The contributions that you've made now will go through the same process and there'll probably be a deeper level of analysis as I go through those things. And I'll look forward to researching that over the Christmas and kind of January, February months when everyone's kind of on the beach, I'll have a good look at these things. And so I just really want to thank you and express my appreciation and gratitude for your contributions. And well, I hope to be talking to the staff here about that sometime next year. So if you have no further questions, what you can do is you can just leave all the bits of paper exactly where they are.

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		I'll collect those. And then Mr. Lang, is it okay if they have a five-minute break, before we go to their next class?
Teacher 1-DT:	13:15	[Inaudible 00:13:16].
Researcher:	13:17	Terrific.
Teacher 1-DT:	13:17	[Inaudible 00:13:20].
Researcher:	13:20	And the other thing is, and also I just want to say a very, very big thank you to our online participant there. I can see that you've noted a few things down in the chat. So if I can just remind you to, when you can, when you get a moment, if you can somehow take a photo of the work that you've drawn, and then if you want to send that through Mr. Lang.
Teacher 1-DT:	13:38	I'll put my email link at the end of the chat.
Researcher:	13:41	That would be very helpful. And then Mr. Lang, you can pass that on to me. So thank you very much for coming back a second time and also for making the effort to join us via Zoom. It's always a challenge when you do this kinds of things by video conference. So thank you very, very much. It's great.
Teacher 1-DT:	14:00	All right, thanks Kelly.
Teacher 2:	14:05	No problem. It was great being here.
Teacher 1-DT:	14:08	Nice to see you.
Researcher:	14:08	Terrific. So you could even just copy those things out of the chat.
Teacher 1-DT:	14:12	Yeah. That's what I'm going to do.
Researcher:	14:13	And just throw them straight to an email. All right. So I'll just press pause here.

Table 80 School B Phase 1 Follow-up Interview Data Reduction Table

School B – Phase 1 **Concepts** Identified in the Raw Data	School B – Phase 1 **Relationships** Identified in the Raw Data	School B – Phase 1 **Propositions** Identified in the Raw Data
Group B01 – Languages students Opportunities Communication Culture Jobs What we're learning. How we're reading it. How we're writing. How we're learning to speak Aspects of culture Intelligence and overall knowledge Think in Indonesian Lost in translation. Values	The links between opportunities and communication. Different aspects of learning the language, and then how they are connected. There's a lot of different ways we're connected through businesses. We're learning new different aspects of culture by learning new words and how to speak. So we know everything, we just have to apply it and we're applying it to different aspects of Indonesian culture. [expands your knowledge] across different subjects and to English speaking skills as well.	Opportunities for more cultural understanding. If we understood their language a bit easier, then we might be able to understand their culture better. We'll have more understanding with them and also opportunities in jobs. If you're really interested in the culture, that will probably inspire you to learn the language. So many more opportunities by understanding and learning Indonesian. Even just putting that you've learned Indonesian on your resume would give you better opportunities for good jobs. A big motivation for me because I would like to talk to them in Indonesian. Learning a new language really improves your memory skills. It just expands your knowledge in a range of different ways and not only in just that one subject. I just generally feel like it expands your mind. I think it just expands, I feel like, your brain's function. It just is constantly thinking in a different kind of way to people who don't know multiple languages. I guess it also shows how much we've progressed in learning Indonesian, and I think I find that fascinating. It just gives you a little more opportunities in that way. So not really knowing the language is almost not like being there to experience what actually happened.

School B – Phase 1 **Concepts** Identified in the Raw Data	School B – Phase 1 **Relationships** Identified in the Raw Data	School B – Phase 1 **Propositions** Identified in the Raw Data
Group B02 – Languages students, plus DT Teacher. Critical thinking Creative thinking Culture Self-expression Connection Authentic design Preferred future Altruistic motivation Human-centred design Empathetic design Social issues History of the language	The linking (interplay) of critical and creative thinking. Misconstrued about making something for yourself. [and I think that devalues the subject sometimes] **Note:** relationship and proposition stated together. If you just compare North India to South India you see so many changes.	Making the world a better place. I think the value of design stems from that philosophy that through critical and creative thinking ... the intention is to make the world, the person next to you, whoever it might be, through your design process, a little bit better. But helping others through the design process and I think the value in this subject is that. I think, to me, learning a language is almost the ultimate form of trying to understand someone else's point of view because it's the way we interact with each other all the time. [languages] can expand the way you can share knowledge. Because we interact online a lot, it's a lot more important to know other languages in order to experience more. You can never translate something 100% with all of the cultural context. My responsibility to give the students skills and strategies for thinking that they can move beyond or integrate into all areas. I think the value that design has is that it utilises and integrates ever other learning area. I think the creative process parallels the scientific process because when you break it down, it's about formulating problems, defining problems, testing, creating methodology and solutions that might work. I disagree with the notion of STEM. I think STEM as a concept oversimplifies the integration. If we really want to integrate all these areas, we have to bring those social sciences and humanities in. ...where we take out the human focus when we look at STEM all the time and it becomes an engineering course. ...and I think that devalues the notion of an integrated course. IT's less about a list of words and it's more about how those words shape mindsets and attitudes.

School B – Phase 1 **Concepts** Identified in the Raw Data	School B – Phase 1 **Relationships** Identified in the Raw Data	School B – Phase 1 **Propositions** Identified in the Raw Data
Group B03 – 6 year 9 Design and Technology students Linking Design process Conceptual design Hands on Problem solving Making stuff Machinery Emerging technologies Digital design Commerce Art Risk taking	It can help with other subjects like maths and science, with the designing and problem solving. It goes both ways. It goes from, you could say, maths to DT, and DT to maths. It's almost like a pie, the mathematical ideas that we might learn in maths and then applying it to design technology. I think the rationale is important, because it shows the reasons behind why you chose to do something. Commerce, like looking at maybe how your designs influence the world. New ideas and concepts of how you can perform the ideas. And also, maths for more the design, kind of how you're actually designing things.	It lets me work with my own two hands. Because I get to show my own creativity, and it's a lot less boring than typing on a computer. There's no point researching if we're not going to apply ourselves to that topic. There's no point having something if it's not going to serve some sort of aesthetic or functional purpose in your design. I think that the idea of design and the idea of these new technologies, them travelling to these new cultures, I think it encourages a lot of innovation. I think it's important that countries sort of rebound of each other. How they communicate with each other is a big part in technology. I think that design is sort of the language of the future, because right now people are designing things for themselves to make money, not for the world to be better...
Group B03 – 6 year 9 Design and Technology students Linking Design process Conceptual design Hands on Problem solving Making stuff Machinery Emerging technologies Digital design Commerce Art Risk taking	It can help with other subjects like maths and science, with the designing and problem solving. It goes both ways. It goes from, you could say, maths to DT, and DT to maths. It's almost like a pie, the mathematical ideas that we might learn in maths and then applying it to design technology. I think the rationale is important, because it shows the reasons behind why you chose to do something. Commerce, like looking at maybe how your designs influence the world. New ideas and concepts of how you can perform the ideas. And also, maths for more the design, kind of how you're actually designing things.	It lets me work with my own two hands. Because I get to show my own creativity, and it's a lot less boring than typing on a computer. There's no point researching if we're not going to apply ourselves to that topic. There's no point having something if it's not going to serve some sort of aesthetic or functional purpose in your design. I think that the idea of design and the idea of these new technologies, them travelling to these new cultures, I think it encourages a lot of innovation. I think it's important that countries sort of rebound of each other. How they communicate with each other is a big part in technology. I think that design is sort of the language of the future, because

School B – Phase 1 **Concepts** Identified in the Raw Data	School B – Phase 1 **Relationships** Identified in the Raw Data	School B – Phase 1 **Propositions** Identified in the Raw Data
		right now people are designing things for themselves to make money, not for the world to be better... ...I feel like in the future, design needs to change slightly so it's not looking at the, "Can we make something that's better than everyone else, just so we can make money?" ... ...Can we make things together that will help change the way the world functions at the moment? Language, because in the future, jobs, there's going to be a lot of design jobs. Different opportunities might occur in different places, and it's not always going to be where you are or what language you speak. It kind of gives you a new perspective to look at things from, because design, even though it has all the planning, and it may seem really tedious, it also kind of forces you to think in the way that the person you're making this for might have to think. Like with the empathy part of the design process, that's really important, because it makes you actually get into the issues and think, if I was this person, what would I want from this product. Being unique, being more creative and more hands-on kind of tasks. I would like more freedom in the workshop. Especially in designs, risking in designs and things, although we need more opportunity to create a risky design that might not work, but if it did, it would be really cool. Asking us to be really creative and really push the creative boundaries outside of the box, but then they're restricting us with what we can use, the materials we can use, the way we can use it.
		...I feel like in the future, design needs to change slightly so it's not looking at the, "Can we make something that's better than everyone else, just so we can make money?" ... ...Can we make things together that will help change the way the world functions at the moment?

School B – Phase 1 **Concepts** Identified in the Raw Data	School B – Phase 1 **Relationships** Identified in the Raw Data	School B – Phase 1 **Propositions** Identified in the Raw Data
		Language, because in the future, jobs, there's going to be a lot of design jobs. Different opportunities might occur in different places, and it's not always going to be where you are or what language you speak. It kind of gives you a new perspective to look at things from, because design, even though it has all the planning, and it may seem really tedious, it also kind of forces you to think in the way that the person you're making this for might have to think. Like with the empathy part of the design process, that's really important, because it makes you actually get into the issues and think, if I was this person, what would I want from this product. Being unique, being more creative and more hands-on kind of tasks. I would like more freedom in the workshop. Especially in designs, risking in designs and things, although we need more opportunity to create a risky design that might not work, but if it did, it would be really cool. Asking us to be really creative and really push the creative boundaries outside of the box, but then they're restricting us with what we can use, the materials we can use, the way we can use it.
Group B04 – 6 year nine French students ATAR Beneficial Occupation Social life Language (and culture) Food (cuisines) Art (within the culture) Vocabulary History	Sometimes you understand the culture more than, say, a non-European one, but then other times you may feel like it's got its similarities.	Knowing a language can help you in terms of what occupation you want to choose and where you might end up living at the end of that occupation. If you learn the language, it means you gain more of an understanding on how cultures work and how everything kind of resides in their beliefs... ...It also helps you understand the way they kind of treat their way of life.
Group B05 – Year 10. Four D&T students, two French students. Imagination Ergonomics Design technology Future Thinking outside the box	Understanding people, both what they say and holistically. Culture can make it more formal [make people formal]	Love for the subjects [Design and Technology] Something that draws me to D&T is like the hands-on.

School B – Phase 1 **Concepts** Identified in the Raw Data	School B – Phase 1 **Relationships** Identified in the Raw Data	School B – Phase 1 **Propositions** Identified in the Raw Data
Factors influencing my selection. Communication Travel Words Culture Conceptualising design Understanding people Future jobs	What design or whatever could look like in the future and how what we do now can impact that. Design something that's suitable for the future... ...and how people are changing. It's interesting to think about what language could look like in another 10 years. I think French sort of improves your English vocabulary. The technology needed for each culture would be different. I'd say that D&T probably aligns with art a bit as well. You would also need to know how people think and act if you are linguistics. I speak another language at home as well. You can kind of see the difference and the similarities as well.	So basically, I like the creativity aspect of languages. Bring out the best of the best from all over the world together to create something with technology and stuff like that is really achievable. I feel that it's formed by culture. I think that in D&T there's a lot of trying to think or trying to create a product or design something that people haven't done before, or that's different to what's already been done. I just think that the cultural aspect is very, very different. Honestly, I would like to see more girls in the STEM area. We bring like a different perspective to it because there are a lot of boys in the STEM rather than girls. It kind of should be equal, I guess. I guess boys are more like sort of stereotypically, like are more into the woodwork and practical stuff.

Table 81 School B Phase 2 Follow-up Interview Data Reduction Table

School B – Phase 2 **Concepts** Identified in the Raw Data	School B – Phase 2 **Relationships** Identified in the Raw Data	School B – Phase 2 **Propositions** Identified in the Raw Data
Group B01 – Languages students, 4 year 10, 1 year 9 Learning new skills Improving old skills Learning new words Practising specific phrases Learning the word tenses Structure Skill Creativity Intrinsic motivation Connection	The language sort of connects to everything... ...not just learning the words and stuff. Connections between countries and creating connections between the languages in some way. I found it hard to link creativity that aspect into Indonesian, because I'm not a very creative person...I'm far more logical. I don't really link them together, but those are just kind of things that I prefer because I don't really like using creativity. I think it's just natural curiosity because you can't really learn a language without understanding it, that's not possible. I guess by understanding its culture or how it works, I think it's just something that we want to do. I don't really know why. It's kind of random. I think it's because understanding comes more with the grammar, I think. And it's not more about just knowing, it's about understanding. And in English, you just know the language, you don't really understand it. But if you learn a language, then you have to actually understand why you have to order it like that and how to order it and stuff like that.	To learn better. Language is really, it's got so many benefits, because they've both got creative aspects, but just in different ways. Whilst in other subjects like DT, you sort of have to use the other part of your creative mind in which to...You make something that's new, that's not been brought up to you before. ...Whilst in language, you have to use the ones that have been brought up to you before, the ideas that have been brought to you before. With the creative subjects like English, Art, and DT, there's more of an open playing field in which there's so many ideas that you could come up with but in Indonesian and other languages you've kind of got the smaller playing field with words you've got to learn and you've kind of got to just focus on that area first before you really expand. I think with language it's different because it's a whole new sort of world when you go into the classroom. Because in my first one [concept map] I didn't really think too much about the creative aspect of it, but now after seeing what the technology students brought up, I was like, oh yeah, I like that idea. I think for me it's been quite a big change and I think I've been influenced by what they've been writing, because I think in the last one, I talked a lot about understanding, but now I'm talking more about learning the skills.... I think, yeah, I've been influenced by what the technology students have written. I think I looked a lot closer at the solving and creativity aspects, because before I just talked about understanding and how that can lead to opportunities... ...I talked a bit about connections, but I didn't really think about the solving and creative aspects and how that links together, and then how that links back to the understanding of the language. My old one [concept map] didn't really have many connections between the things, and it was more streamlined, but now it's sort of more connections and things might have multiple things on them, because a lot of things can

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		be applied to other things in Indonesian. It's more that it's like the grammar and stuff and the way the language works was...I elaborated more on that than my last one.
Group B02 – 4 year 10, 3 year 9 Design and Technology. Intelligence across the subjects Time management research skills Writing skills Understanding Both sides of the brain Learning Fun Problem solving Enjoyment	You see a vague similarity between the difficulty of solving a mathematical problem and the solving of a design problem [researcher comment] ...Yeah. Absolutely. [endorsed by participant.] Because DT is more practical and stuff. And that's why people find more enjoyment out of getting to the solution. And then once you get there...I'd say that links to the connection part as well. In DT, to find a solution, you need more of a connection to the problem. Whereas with DT, it's more about connecting to what the problem is, why you need to find a solution to the problem. I guess that's when the design process really comes in. Because the major part of it is empathy and understanding the problem and defining the problem. ...And basically, being in their shoes so you can see how they eel about the problem and what the problem actually is. [Concept proceeding from relationship: problem solving]	DT is very...it's very creative, but it's also very structured. It's just a matter of doing something and designing something that helps it be the best product possible. Because in design and technology, it has heaps of branches and if you really put into the learning, then you can gain benefits, for just in general, and in life. The things you'll learn in DT will generally convert over to like, you can use it in life. And later in life. Design and tech isn't really as connective as languages would be. Definitely in the workshop, allows me to be more creative. It makes it easier to learn because it's enjoyable to learn. I don't really know how to explain it. It's just enjoyable to learn in DT, I guess. You are not getting talked at by the teacher. You're actually going out of your way and making something. I think if you're enjoying what you're doing as well, you're more willing to try harder and put more effort into it. [Concept proceeding from proposition: enjoyment] And DT is kind of different from other subjects, because time sort of flies by when you're in the workshop. Provide different perspectives on the problem. Not all problems can be solved the same way.
Group B03 – 6 year 9 French students, 1 year 10 Russian student (via Zoom) Learn new skills Vocabulary Writing Listening Speaking Occupational Create new opportunities. Open up new doors Boredom	Because you can intertwine it guess, with other subjects. I think in relationship being creative and problem-solving, learning a new language opens up a different way of thinking and a different perspective on how you look at different things.	You can understand those in a different way, and you can think of more solutions to those problems. So language as a pathway to problem-solving [researcher comment] Mm-hmm [endorsed by participant] I think helping other subjects like English about different writing in a different language, it can help you

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		think of how to do that in a different way. So it's not just about knowing and understanding the difference, but experiencing and doing the difference as well [researcher comment] Yes [endorsed by participant]

Appendix K – School C, Phase 1 & 2 Follow-up Interviews, Audio transcripts, Data Reduction Tables

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Researcher:	00:01	With us today at school C we have Year nine and 10 languages students. The languages students are doing French and the technology students are doing engineering studies and IST. Is that correct?
Participant 2:	00:12	Yeah.
Researcher:	00:13	All good. Okay. We'll open this up by saying when you look at what you've drawn, can you think about keywords that might come out of that? Could you look at what you've drawn and say, "I could summarize it with this word or that short phrase." Keywords might be two words together. What do you think?
Participant 2:	00:33	Yeah, yeah.
Researcher:	00:35	And what might they be? So speak up.
Participant 3:	00:38	I used expression a lot and I used understanding like the world.
Participant 2:	00:44	I use a lot of creativity and inspiration.
Researcher:	00:47	Yep. And that's from the languages perspective?
Participant 3:	00:50	Yep. Languages
Participant 2:	00:52	And Engineering. Yeah.
Researcher:	00:52	Oh, and engineering.
Participant 2:	00:52	Yeah.
Researcher:	00:53	So from the engineering perspective there, can you just say that again?
Participant 2:	00:56	So Engineering perspective. I feel it more about creativity and an inspiration.
Researcher:	01:04	Okay. Any other key words? Any other key ideas that come out?
Participant 4:	01:09	I used the word experience a lot. I'm doing languages and because I really wanted to gain experience and abilities in using another form of communication.
Researcher:	01:22	When you say experience, what do you think those experiences might be?

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Participant 4:	01:27	The ability to communicate in a foreign country that isn't an English speaking one. And also in terms of being bilingual, I think that experience is quite good because it opens up a lot of doors in terms of it makes a lot of other subjects a lot... You can apply skills from a language to other subjects.
Researcher:	01:49	How so?
Participant 4:	01:52	A lot of memorization and rote learning is in languages and that helps a lot in some other subjects like maths sometimes.
Researcher:	02:00	Okay. So a bit of subject crossover from learning languages.
Participant 4:	02:03	Yeah exactly.
Researcher:	02:04	Any other key ideas that have come out of this?
Participant 5:	02:06	I know I use the word opportunities a lot.
Researcher:	02:10	Yeah, from the languages perspective?
Participant 5:	02:11	Yeah.
Researcher:	02:13	Why do you think about opportunities?
Participant 5:	02:15	Because I think that languages enables a lot of different opportunities to come from knowing that different language, especially for the future, traveling, future jobs as well and also spreading of culture, like the opportunity to be able to actually do it.
Researcher:	02:30	Do you see similar value that you've just talked about there in other subjects? What makes languages different?
Participant 6:	02:38	I guess because it's more of a different form of communication, whereas in the other ones it's more of focusing on bettering a skill you might already have.
Researcher:	02:47	Okay. Any other key ideas that have come out of this?
Participant 2:	02:53	I'll also say to go with languages like she said, with the engineering perspective of opportunity with the future projects, that might be prosthetics, flying cars, how that could be an opportunity for engineers or designers or wherever the creative side of things are, to create future things for people who need it. With languages engineers could create something to do or

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help in a language learning. So I think these two subjects relate in a way with the thing of opportunities in future.

Researcher: 03:30 Okay. Does anyone have something that they would say in response to that?

03:34 Does that sound unusual that there would be a connection between these two subjects?

Participant 4: 03:50 No. No, I don't think so because there is I think a bit of a crossover. But again, I don't do engineering so I'm not entirely sure what those would be. But I feel like a lot of skills that you would learn in either subject could be applied and vice versa.

Researcher: 04:09 Was there anything that people found hard to draw? When you looked at this exercise in front of you and you thought, I'm just not sure I can represent this on paper, were there any things that came up like that?

Participant 9: 04:22 I wasn't sure if I was supposed to do it in a sort of mind map, concept map type of situation or more of a kind of piece of art, that sounds pretentious, but that type, I wasn't sure what format I could conceptualize an interest in the subject, if you know what I mean?

Researcher: 04:39 Yeah.

Participant 10: 04:40 I found that, I was trying to think about how in French it feels like you think very differently compared to other subjects and I couldn't quite figure out the right words to express that because it's very, you don't just move from one topic to another, you have to relate everything back and you've got to connect things and build upon them in a different way then let's say math, where we'll go there's one thing, now you learn a different thing. So you'll learn one and here is another thing, I'll use them together or use them separately and apply them in a really different way.

Researcher: 05:09 So you actually find that your thinking is different when you start to think in French?

Participant 10: 05:14 Yeah, start to connect them differently.

Researcher: 05:16 So do you actually find yourself wandering through school from time to time breaking into French thinking and then suddenly go, oh hang on a second, I'm not in French anymore.

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Participant 10:	05:25	Yeah, right. I do sometimes occasionally. It's definitely a distinction between thinking in French mode and thinking normally.
Researcher:	05:33	Right. Do you find that that gives you a bit of an aha moment when you suddenly realize that you're thinking in another language?
Participant 10:	05:40	Sometimes. A lot of the time its just, I struggle to always be able to go into that. A lot of the time I'll be in French and I just won't be able to understand everything as well as I normally can because I'm not thinking in the right mindset yet.
Researcher:	05:56	Anything else that people thought was unusual to draw?
Participant 2:	05:58	Well I wouldn't say any unusual drawing, but like what he said with how he can link his French and how his thinking throughout the day, me being an engineering student my mind map or how I conceptualize STEM is different than maybe how he will if he did STEM, because I also do art and my thinking when I do art is much like engineering, learning engineering I think much like art. So with my thinking and the subjects they sort of link together, which I think I'm really happy about. And then in mathematics, when I think about a certain problem, especially when it has to do with shapes, I feel like I can link to it, especially since I do engineering.
Researcher:	06:45	Okay. What are the things that you found were easy to represent graphically? What just kind of flows out onto the page?
Participant 4:	06:53	It was a lot easier to represent the sort of factors that influenced our selection of languages or at least-
Researcher:	07:01	Really?
Participant 4:	07:01	... in my case it was languages.
Researcher:	07:03	Okay.
Participant 4:	07:03	Yeah, because I found it a bit more difficult to visually and with a pencil conceptualize what languages means to me. But it was easier to show why we chose it because I felt like I'd thought about that more.
Researcher:	07:25	Okay. The question of value is a difficult one, particularly when you haven't, well as you get older it's a little bit easier to look

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back because you've got more years to look back on, but at your age you're generally looking forward more. When you think about value and you think about trying to represent value, what kind of things does that conjure up? Can you use some keywords to describe that? Things like difficult, challenging, confusing, unknown, anything like that come out?

Participant 4: 08:00 Experience because you can gain experience.

Researcher: 08:01 And experience is valuable to you?

Participant 4: 08:02 Yeah, exactly. I feel like it's gaining experience whether you had a good or a bad experience, which just helps you learn more about different parts of languages perhaps.

Researcher: 08:17 Sometimes it's easier to think about value in terms of value for money. Let's say you go to a movie and you really enjoyed the movie and you think "Oh that was worth 15 bucks." Or you go to a movie and you think, "Oh that was a dud, I didn't get value for money." If you applied the same sort of filter to your subjects, how would you describe that sense of value? Would you think that you're actually getting value for money?

Participant 10: 08:41 Yeah, I think that especially in French, that it teaches you a lot about communication and how to express yourself because you've got to learn how to use only really limited words that you know and everything and being able to express yourself the correct way or communicate with others in the way you intend is a really valuable skill to have.

Participant 2: 09:00 And I would say in terms of value that you create a project in engineering, it might be very valuable, beneficial like a prosthetic arm or something that's beneficial to the patient or even if it's so minimal being a phone case, the value of it is still just as much as the prosthetic hand because they're both useful, you use it and I think with engineering there's a possibility of everything being valuable no matter what.

Participant 9: 09:27 And as he said over there, I definitely think that there's a lot of value in languages because being able to communicate, as he said and express yourself properly and correctly is really valuable. But to be able to do it in more than one language, in more than one geographical location I think is definitely helpful because that's something that you need to function.

Researcher: 09:53 When we think about culture and what goes on beyond our borders, when you think about the subject that you do, does

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		anyone here get a sense that the subject is bigger than themselves or bigger than your local environment?
Participant 2:	10:07	Extremely.
Researcher:	10:08	I mean you live in the Western, well you're here in what we might broadly call the western part of Greater Sydney. Do you think about your subject only in terms of what's going on around here or do you have aspirations of what's going on out there and how far does that go?
Participant 2:	10:26	A long way.
Researcher:	10:26	A long way?
Participant 2:	10:27	Yeah.
Researcher:	10:28	How far? The other side of the world?
Participant 2:	10:30	Definitely like Elon Musk going to Mars, like the possibilities of it and well spaceship going to Mars, they use engineering. So I guess not just used in this area but out of this world, basically yeah, if it goes out of the world.
Researcher:	10:46	Elon's actually a very good friend of mine, he doesn't know that but that's just the way I like to think about it. So I hear you. In fact, I actually watched the SpaceX live streams and stuff like that because I just wish I was a rocket scientist but I never got there. So what about the languages people? I mean obviously you're in an English speaking country, you're in Australia which is arguably down on the lonely side of the planet. You could argue that there's not much going on here. How does that make you feel in terms of what you are learning, in terms of where you want to take this? Where does it go?
Participant 4:	11:24	It is definitely hard to imagine sometimes languages in Australia because obviously French is a language spoken in many areas of the world. But in our location at the moment we are not very diverse in terms of language, at least in French. There aren't many French speakers where we live so it's kind of hard to gain experience so you definitely get often the sense that this is much, much bigger than you because you don't have much natural exposure other than outside of school to the languages.
Participant 10:	11:57	I find that with the culture and learning and language you learn a lot about the culture and while learning a language you start to wonder if that's how they speak it there and a lot of things

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		like, they've got a lot of different sayings that they use and you gain a big appreciation for the big differences they have there. And it makes me really curious to go there so I can in person talk with them the right way and understand what it is like there because these different cultures are always really interesting to see.
Researcher:	12:28	That's interesting you mentioned the word culture. What sort of impact do you think another culture has on your understanding of the world and the value of what you do here? Is it just about being able to speak or what about that whole sense of living differently? Does that make an impact on your perception of what goes on around here? Yeah.
Participant 12:	12:48	I think culture has a big thing to do with it because it depends on where you learn the subject but also where you can further learn it. Because if you're learning it somewhere where you have locals that speak French, you more learn the conversational side of it compared to the book work of it. You don't learn just the basics and the actual definitions. It's how to have a conversation, even slang or how they would shorten words and things like that.
Researcher:	13:29	Okay. I think I know where you're coming from because when I taught German out of area, I'm not a languages teacher but I can speak German and occasionally you get the opportunity to do that. I looked through the textbook and I thought actually this textbook is pretty good. The way it sets out the language, the way it sets out the rules and the grammar and so forth. It was really interesting because I said, "Okay, here's the textbook and we're going to run through it like this and we'll do these exercises." And we did and the students responded and then I said, "Right now let me tell you how Germans say it." And it was really interesting because it's the same rules, the same language, but there's just this slight difference to the way that it's expressed and that's something that as you say, it doesn't come out of the bookwork.
	14:15	How much do you think that, that sense of value is conveyed to you in your classes? Do you get a sense that that's part of what you are learning about or is it what you think that you would like to learn about if it was your ideal world? How much of it is coming out in the curriculum?
Participant 9:	14:31	Sometimes I feel like when we are doing French and it's sometimes a bit monotonous for lack of a better word, I feel like sometimes it doesn't feel like I'm gaining anything. But there

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		are other lessons where I feel like I'm really benefiting from it, from doing it and I'm glad that I chose French as a subject because it definitely feels like it's worth it, worth time and the effort.
Researcher:	14:56	So you're in year 10, so arguably you've done five and a bit terms now of French.
Participant 9:	15:01	Since year three.
Researcher:	15:02	Oh, since year three?
Participant 9:	15:03	Yeah.
Researcher:	15:03	Okay. So you're a long term French learner. Looking back over those years now when you look back you go yep, that was definitely a valuable use of my time?
Participant 9:	15:12	Yeah, I think so because again there are a lot of skills you can gain from doing a language and I think now having done French for kind of a long time, not as long as a lot of people, but I feel like if I was put in France or a French speaking country, I would be able to apply those skills in a meaningful way that shows that I've benefited from doing French for so long.
Researcher:	15:40	In terms of what your ideal situation would be like, I mean you are in an organized subject, it's an organized curriculum. If you could just step aside from that for a moment and just dream a little bit, what are the kind of key concepts that you think that would really help to add that extra zing of value for you to really try to get the most out of the subject? What kinds of things would you look for?
Participant 10:	16:09	I found that at the end of some of our lessons for us, we would do this thing where we'd go through and we'd name a fruit or something and whoever couldn't name a fruit, they'd sit down and we really had to apply what we'd learned. We'd have to come up with something on our own, like a generational theory style thing and we had to actually make use of what we were learning or speak a sentence or have a small conversation with our teacher. And having those things where we actually have to use our French or come up with our own or be creative with it or compete against anyone else in an activity style perspective, those are the times that I feel like I'm getting the most out of my French and I'm actually understanding it rather than just writing it down.

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Researcher:	16:44	So being challenged, is that what you're trying...
Participant 10:	16:46	Yeah and being forced to use it.
Researcher:	16:48	Okay. Forced to use it.
Participant 9:	16:50	Same, because as he said, being able to use what you've just learned on the spot in a sort of independent and creative way really helps you to realize, I need to improve on this more or I'm getting better at this. And so it makes it a lot easier to understand where you're at with the language, but also to be able to on the spot in a kind of more closer to a real life conversation, you really have to quickly think about what you're going to say and make it make sense, which I feel like is really helpful in conversational skills.
Researcher:	17:18	Okay.
Participant 2:	17:19	Yeah. And so in engineering, what I especially like is that we do challenges, usually group challenges, it goes over certain lessons and what I like about it is that we get in groups where we have not really experienced enough interaction with that certain person or we have different skill sets and then we're challenged to use these different skill sets with different people to create something out of the minimal material that we have and it opens up our imagination to "Oh, if I have to make a bridge out of masking tape and paper, well what bridge can I make that's going to be the strongest?" And that's one I especially like. And then also getting together the whole class and then brainstorming these different ideas. And recently we did forces on bridges and dams and using those forces how we can then implement that in different projects later on.
Researcher:	18:26	Okay. Some from this side of the room perhaps? If there was a word or a concept that you could think of that would just really help to propel the subject to the next level for you, what do you think it might be?
Participant 6:	18:35	I think that knowing how people, because I do languages. I think knowing how people my age would be speaking and what terms they would be using would be beneficial. Especially since our teacher obviously is a lot older than us, so she wouldn't quite be up to date with sort of terms, if that makes sense.
Researcher:	18:56	Not hip to the scene perhaps?
Participant 6:	18:58	Maybe. Yeah.

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Researcher:	18:59	Okay. So would you say that that was more about connecting with your peers?
Participant 6:	19:05	Yeah, knowing how someone in my position in another country would be speaking in their natural language, I think that would be really beneficial to know, especially if we go over there at this age or at older ages as well.
Researcher:	19:20	If I said to you, "Yes, I can make that happen for you today," how would you like it to happen?
Participant 6:	19:26	I think that it would be good to use it in a group environment within the people in our class and almost saying it to each other and seeing how it feels and how we react and sorts of stuff like that.
Researcher:	19:39	Do you have connections with other students in say a sister school or some sort of a relationship?
Participant 6:	19:43	Not really.
Researcher:	19:43	Would that be cool? Would that be the sort of thing?
Participant 6:	19:43	I think it would, yeah.
Researcher:	19:47	Yeah. Like a Zoom class with some French students who are learning English.
Participant 9:	19:53	Yeah to be able to test the knowledge that we've learned in class and apply to real French speakers would I think give us a bit of context as to where we are, but also if we did have some sort of connection to a school in a French speaking country, it would be cool because presumably they would be doing English, which is why they would be in connection with us. So it would be cool to have that just to test our knowledge.
Researcher:	20:19	I can guarantee you they will be doing English. Yeah, it's the standard thing over there. Do you think the same thing applies for engineering or for technology students? Would there be a benefit in having a connection with a class, maybe not here in Australia or here in Sydney, but overseas?
Participant 2:	20:41	Yeah, I would definitely think so because with how we're learning whether we're learning similar things, whether we have... And then also to explore different ideas that we all might have. And then in terms of linking to languages, if we are on the zoom call for example with a German class learning engineering

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and they could then explore different symbols or different ways that they identify certain things that I think will be interesting for if we futurely go over to other countries and we don't quite fluently speak that language, it'll be cool to learn how these different symbols that influence different projects and just their ideas.

Researcher: 21:23 Great. Is there any concluding comment that someone would like to make? Is there anything that someone would like to say that's not related to any questions that I've asked? Something that you just really want to express or say about the subject that you're doing or a question that you've got about what we've done here today?

Participant 10: 21:37 I find that with learning languages, one of the hardest things is that we do a lot of the same thing over and over again. And when we're learning new phrases we'll do the same type of activity or very similar things. So while it's all new information, it gets sort of monotonous to be doing the same thing. And that when we do activities like I mentioned earlier, that just makes it a lot more fun and a lot more interesting. And it's not just the same motions, it's actually think and try to do something with it.

Researcher: 22:05 Does your languages teacher ever or your French teacher, does your French teacher ever just come into the classroom and never say a word of English?

Participant 5: 22:12 They used to do that in junior school and I found that extremely beneficial.

Researcher: 22:16 Really?

Participant 5: 22:17 Yeah, because I, like he said, have been doing French for a while and I personally found it so pointless in junior school until the last year and a half or whatever it was when our French teacher would come in and would only speak French because that's how you learn English. And I found myself today still doing some of the hand actions that she had accompanied with the word so we get that visual aspect of it as well.

Researcher: 22:41 Isn't that interesting?

Participant 5: 22:42 Yeah.

Participant 9: 22:42 Yeah, exactly. Because in primary school we had a teacher that told us at the beginning of the year, I'm only going to be speaking in French. And I found that was when I learned most of

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		the basis of the foundational French that I know now because she was so, not strict, but it forced us to have to learn the stuff that we'd had since year one or year three or something. But now I feel like, obviously nothing wrong necessarily with speaking English in French if we're struggling, but it makes it a lot harder to have to think on the spot, if you know what I mean, because it's a bit easier.
Participant 5:	23:19	It was also beneficial in the sense that you could connect ideas to the hand action. So she had like [foreign language 00:23:27], she'd go like that, like long. So just stuff like that to this day it helps me remember.
Researcher:	23:33	Great.
Participant 5:	23:33	I think that would be beneficial.
Researcher:	23:33	Yeah.
Participant 12:	23:35	I understand your guys' view of it, but when my teachers used to do that, I had a totally different reaction to it because I didn't understand what was happening. So I'd be trying to figure out what they were saying here, but she's still talking so I'm missing all of that. So it can be beneficial, but it needs to be at the level that the students are at instead of, I believe we were starting to do that way too early and then it just confused everyone and then the teacher just had to repeat what she was saying and it was almost pointless for her doing that because not many people understood it.
Researcher:	24:20	Yeah, I guess that's probably why I never discussed existentialism with my two year old son. For the same reason, way over the top of most people's heads.
Participant 10:	24:30	I find that I relate to a lot of things that we've discussed at this point that being immersed in a different language, whether you speak it very well or not is really, really good for learning about culture and about language. I had the wonderful opportunity of staying in Japan with families for two weeks. I didn't speak any Japanese so we had to communicate, like you could google translate, but I learned a ton about the culture. It gave me a massive appreciation for just how small my part of the world is and how much is out there and that. And trying to communicate with them. We taught 10 Japanese kids how to play cricket, no translation between us.
Researcher:	25:04	Oh wow.

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Participant 10:	25:05	Like 10 kids of us, 10 kids of them, taught them to play cricket somehow. It just is completely different from how you're used to talking to people and it makes it really interesting and really difficult, but you learn a lot while you're there.
Researcher:	25:17	Yeah, I find that fascinating because in 2014 I went to Germany with my wife and son who was then six years old and we went to a playground out in the park and he just goes into the playground and starts interacting with the kids and I thought, "Okay, this will be interesting." And then it took a few minutes for the other kid to realize this kid doesn't understand me, but guess what? They managed to get on. And then the parent came over and said, "What's going on?" And then I explained and "Oh, okay, sure." And that was all fine, but it was interesting to watch people, young people interact like that.
Participant 10:	25:47	Yeah.
Researcher:	25:48	So thank you so much. Sorry, did anyone have any other final comments that they wanted to make? I'm just mindful of the time.
Participant 2:	25:57	I would say one thing, to do with engineering with the whole branching out on the subject. We use one type of software and we use that for modeling projects and I get that's the main software that you use to model but I would like to have like a week or two or even a term or something where we use different programs for certain things. We might try a little bit of animation or something where we can use these different programs. So then out there when we're not in school anymore and we have a job then these programs might be introduced to us but it might be good to have a little bit of a background knowledge of the programs. So that's just one thing I really would like to see
Researcher:	26:38	What program are you using?
Participant 2:	26:40	Solid Edge.
Researcher:	26:40	Okay.
Participant 2:	26:40	And then [inaudible 00:26:44].
Researcher:	26:44	Any other final comments as we wrap this up? No. Okay well I'll conclude the recording there.

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Researcher:	00:01	We'll start the recording here again for phase two data collection here at school C. And with us, we have French students, and an engineering study student and an IST student, and of course one non-participating staff member. So the first question I want to ask you as you consider what you've just done, and remember, I'm throwing this open to everybody, and feel free to speak up and speak loudly so that the machine can hear you. Do you have a sense of... Well, let me ask it this way, was it unusual for you to consider another person's perspective from a different subject in terms of how you think about your subject? Was that an unusual experience?
Participant 2:	00:50	No.
Researcher:	00:52	No, not unusual? Why not?
Participant 2:	00:55	Well, I mean my friends, they all do multiple different subjects and hearing about the different subjects almost on a daily basis so I think creating that connection was a little bit easier considering I know a bit of background knowledge between the both, the two.
Researcher:	01:10	Okay.
Participant 3:	01:11	I found it really interesting because the subjects are very, very different purpose to each other and what they're meant to mean to people is really, really different.
Participant 4:	01:26	While the content of what you've learned in those two classes is quite different, there are quite a lot of similarities in terms of what you take away from both of them, in terms of asking questions and improving.
Researcher:	01:40	Okay, can you think about any other, if you were to think about the similarities, what are the really big ones that came to your mind?
Participant 4:	01:48	You can solve the design things which are similar to translating texts or writing sentences.
Researcher:	01:55	Okay. So you see a similarity between solving and designing, or problem-solving and the problem of communication?
Participant 4:	02:03	Yeah.
Researcher:	02:03	Translating?

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Participant 4:	02:04	Communication and getting things, being able to express yourself properly and grammatically correct.
Researcher:	02:11	Do you see communication, particularly for you as a language learner, of a language other than English, do you see that a little bit like a project for you?
Participant 4:	02:22	Yeah, definitely. It's like you apply similar problem-solving skills, I would assume, that you would have from STEM to languages, to make sure that you are saying the right things in the right way. So it's a bit like a problem.
Researcher:	02:37	Anybody else, was it an unusual experience for you to consider your subject through somebody else's eyes? Did it make any difference to you at all? For example, did anyone think, "Do you know what, this makes absolutely no impact on me whatsoever. I just like my subject for the way I like it?"
Participant 2:	02:58	It definitely does impact in a sense, in a way that they're, how the two subjects are linked together. Like what was said before, definitely they are connected when it comes to technology, with translations and all the different stuff. But this sort of way that they learn languages and answer that learn through experience and with learning as well off the screen, but also between others. And I find with technology, we learn off the screen also by experience and we also do work really well with each other in class as well. So I do think that this link between them both definitely has an impact for me.
Researcher:	03:48	Okay.
Participant 4:	03:48	I actually found that while there are similarities, the way that technology students think about and conceptualize their subject doesn't really change the way I think about French.
Researcher:	03:54	It doesn't?
Participant 4:	03:55	It doesn't, no. Yes, there are quite a lot of similarities but I don't think it changes the way I conceptualize languages.
Researcher:	04:05	Okay. What about some of the languages students over here? Do you make any connection with the way the technology students think about what it is that they do? Any other problem solvers amongst the languages students?
	04:25	Are there things that you would like to see in the languages course or the languages curriculum or the way that you learn

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languages that could be interesting for you to consider or does it all just seem kind of normal?

Participant 5: 04:41 I found that, well, with the way that it's taught in general, we ended up having a discussion in class one time about tests and everything and how it might be... There are a lot of factors that influence in tests, feel like nervous. Some days with this language you just can't speak them well and someone's suggested that you do more competency based things that over time you get judged on what you can and cannot do to give a more accurate picture rather than just what you can do on the day.

Participant 4: 05:07 Well, as in smaller but more frequent assessments, or not even assessments but just sort of quick analysis on the teacher of the students rather than longer and more stressful I suppose, for lack of a better term, assessments that a lot of time is led up to doing.

Participant 5: 05:33 Mentally, I sort of compare it to the... I think it's the hospitality course where you do a bunch of small competence based things that can you do this, can you do this, can do this and you can, that's really your main mark for it if you tend to do all these things. And letting that could really apply for each in the same way or languages in the same way with can you actually do these things?

Researcher: 05:52 Yep. What about technology, is that more in your subject, is it more about a, here's the thing that I need to solve, can you do it? Is that, do you see that being more obvious in the technology courses than maybe in the languages courses?

Participant 2: 06:06 I definitely see the sort of solving area of it, but when it comes to technology, in my opinion and view of it, you do have a set thing you can do and make and experiment with, but you also can design it in your own way. If I'm making a jet engine, the blueprints may be like that, but I might design instead of a four-fin propeller, I might have an eight-fin propeller, I might alter the way instead of going off the design I meant to be doing. And so it sort of opens up your mind to what you can do more to sort advance onto the area supposed to be doing and so advance your skills.

Researcher: 06:50 Yeah. So you've all made choices to follow this path. Some of you are earlier on in the path... I know that some of you have been doing languages for a long time, but we do have Year 9 students here and Year 10. So we've got Year 10 technology

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students, but we've also got Year 10 languages students. So you've set yourself on this path and we're about halfway through the year. Was it a good path to take?

Participant 2: 07:16 Yeah, definitely.

Participant 4: 07:18 The skills that we've learned, well, I can't speak for the STEM technology students, but I can definitely say from languages the skills that I've learned have been invaluable and not just in terms of the content that we learn, but the comprehension and memorization and those sorts of skills can be applicable and lots of other areas, which is why they're so useful.

Researcher: 07:39 That's really interesting. Well, let's think about it like that then because we've got about five minutes to go. If you could think about telling someone why it's valuable that what it is that you do without saying, so let me put it this way, there are two ways that we can talk about the subjects that you do. So for example, in technology I could say, you learn about this technology, that technology and you learn these skills and you learn how to use these pieces of equipment and that's what it is.

08:06 Or as in French you might say, I get to speak another language, I can read and I can write and I can go and communicate with other people and I can read signage and I can buy a train ticket and I can get around, they're what we might call utilitarian aspects or the practical doing aspects of what it is that you are studying. But let's go a little deeper then, and figure out or try as we just heard, what's the key takeaway for you now that you've said, "Yes, this is definitely worth...." Or generally there's been a reaction that says, "Yes, this is a path worth taking." How would you sell that to someone? How would you express that to someone to try to get across that sense of value that you hold that you could potentially tell to somebody else?

Participant 5: 08:51 Personally, I see in tech there's a wide sense of this grand purpose of helping a lot of people change in the world and that's something that languages overall can't really do to the same degree. It lets you help some people in really small ways, but it also helps you yourself because when you're learning about another culture, you learn about how they work, their systems all about them. And that makes you go, "What about mine? How's mine different? Where could we do better?" It makes you review your whole world and in your whole environment that you live in based on how they deal with them.

Researcher: 09:25 And that's valuable to you?

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Participant 5:	09:26	Yeah, because it means I can understand my life and the lives of people around me a lot better.
Researcher:	09:30	Yeah. Any other expressions of value? How would you sell it to someone? If someone said, "Oh, you do French," or "You're doing a technology subject, how do you find it, is it great?" What would you say to them?
Participant 2:	09:44	I want to change the world.
Researcher:	09:47	You want to change the world?
Participant 2:	09:48	Well, it's practical of people say about when they say technology, but it's a technology as or STEMers a thing, it's a [inaudible 00:09:56] that can change the world. And I definitely think, definitely that is one of the purposes of it. But there are also, I thought, smaller key areas where doesn't it change the world, it may change person's life or something or maybe they will. Definitely does have a big aspect to it, but yeah, languages, they don't get the spotlight as much as technology does but I do think that they do have a purpose in their way. Languages, technology goes bad someday, you might need a translator that languages could help us in many ways. So I definitely think, as technology does have a bigger branch of what we can do in the world, languages definitely also has their place and where they can help everyone in the world as well.
Researcher:	10:41	You've made a great comment there about the spotlight. I'll put it to the language of students. Do you feel like languages needs a bigger spotlight?
Participant 4:	10:48	Yeah.
Researcher:	10:48	Would you like a bigger spotlight?
Participant 4:	10:50	I think, being bilingual is underrated.
Researcher:	10:52	It's underrated.
Participant 4:	10:53	Yeah.
Participant 6:	10:59	And a lot of people don't realize how hard it actually is to learn a language.
Participant 4:	10:59	People think, you just go to class and you just memorize vocab but it's really hard sometimes to construct sentences in a way

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		that isn't unusual in your own native language, it's quite difficult.
Participant 6:	11:09	Because it's not word for word. You have certain things you have to conjugate it differently, subject-verb [inaudible 00:11:14].
Participant 4:	11:13	Sentence structures.
Researcher:	11:16	If you could build that big spotlight, what would it look like?
Participant 4:	11:20	Encouraging more students to pick languages so that they can, I suppose, this is sort of quite pragmatic, being bilingual in a multicultural society could be helpful for the future.
Researcher:	11:36	Yeah.
Participant 6:	11:37	Doing it from a younger age. So doing it, influencing it in more primary schools, just to build with that sort of knowledge early on.
Researcher:	11:44	Do you think that would help it just to become more normal as you go into high school?
Participant 6:	11:47	Yeah.
Participant 5:	11:47	Definitely, and I think it'd be better have a view differently because you look at somebody say, "Commerce, this is something you should do. It helps you live your life." And I think French should be, all languages overall should be in that same vein.
Researcher:	11:59	Yep.
Participant 5:	11:59	It's a really good skill that you want to have just like commerce.
Researcher:	12:04	I'm mindful of the time I think you've produced wonderful responses, is there anything that someone would like to say that they felt that they haven't said that's maybe on a different question or a different topic? And you might be thinking, "Oh, we talked about that five minutes ago, but I didn't get to say it."
	12:20	Any concluding statements?
	12:24	Okay, I'll finish the recording there.

Table 82 School C Phase 1 Follow-up Interview Data Reduction Table

School C – Phase 1 **Concepts** Identified in the Raw Data	School C – Phase 1 **Relationships** Identified in the Raw Data	School C – Phase 1 **Propositions** Identified in the Raw Data
Group C01 - French, Engineering, IST students Expression Understanding, the world Creativity Inspiration Engineering Experience Opens up a lot of doors. Opportunities Future Travelling Future jobs Spreading of culture The engineering perspective of opportunity with future projects	I'm doing languages and because I really wanted to gain experience and abilities in using another form of communication. You can apply skills from a language to other subjects. [how?] A lot of memorisation and rote learning is in languages and that helps a lot in some other subjects like maths sometimes. And then in mathematics, when I think about a certain problem, especially when it has to do with shapes, I feel like I can link to it, especially since I do engineering. I found it a bit more difficult to visually and with a pencil conceptualise what languages mean to me. But it was easier to show why we chose it because I felt like I'd thought about that more.	Because I think that languages enable a lot of different opportunities. But I feel like a lot of skills that you would learn in either subject could be applied and vice versa. In French it feels like you think very differently comparted to other subjects and I couldn't quite figure out the right words to express that You have to relate everything back and you've got connect things and build upon them in a different way then let's say math, where we'll go there's on thing, now you learn a different thing. [Thinking]...yeah, start to connect them differently. It's definitely a distinction between thinking in French mode and thinking normally. Experience, because you can gain experience. I feel like it's gaining experience whether you had a good or a bad experience, which just helps you learn more about different parts of languages perhaps. Being able to express yourself the correct way or communicate with others in the way you intend is a really valuable skill to have. I think with engineering there's a possibility of everything being valuable no matter what. I definitely think that there's a lot of value in languages because being able to communicate, as he said and express yourself properly and correctly is really valuable. But to be able to do it in more than one language in more than one geographical location I think is definitely helpful because that's something that you need to function. [in the context of languages] And it makes me really curious to go there. I'm glad that I chose French as a subject because it definitely feels

School C – Phase 1 **Concepts** Identified in the Raw Data	School C – Phase 1 **Relationships** Identified in the Raw Data	School C – Phase 1 **Propositions** Identified in the Raw Data
		like it's worth it, worth time and the effort. I would be able to apply those skills in a meaningful way that sows that I've benefited from doing French for so long. What I like about it is that we get in groups where we have not really experienced enough interaction with that certain person or we have different skill sets and then we're challenged to use these different skill sets with different people to create something. I think knowing how people my age would be speaking and what terms they would be using would be beneficial. If we are on a Zoom call for example with a German class learning engineering and they could then explore different symbols or different ways that they identify certain things that I think will be interesting. I find that learning languages, one of the hardest things is that we do a lot of the same thing over and over again... it gets sort of monotonous to be doing the same thing. Being immersed in a different language whether you speak it very well or not is really, really good for learning about culture and about language. It gave me a massive appreciation for just how small my part of the world is and how much is out there.

Table 83 School C Phase 2 Follow-up Interview Data Reduction Table

School C – Phase 2 **Concepts** Identified in the Raw Data	School C – Phase 2 **Relationships** Identified in the Raw Data	School C – Phase 2 **Propositions** Identified in the Raw Data
Group C01- French, Engineering, IST students Skills	Mentally, I sort of compare it to the...I think it's the hospitality course where you do a bunch of small competence-based things. Personally, I see in tech there's a wide sense of this grand purpose of helping a lot of people change in the world and that's something that languages overall can't really do to the same degree... ...It makes you review your whole world and in your whole environment that you live in based on how you deal with them.	I found it really interesting because the subjects are very, very different purpose to each other and what they're meant to mean to people is really, really different. While the content of what you've learned in those two classes is quite different, there are quite a lot of similarities in terms of what you take away from both of them...in terms of asking questions and improving. You can solve the design things which are similar to translating texts or writing sentences. It's like you apply similar problem-solving skills, I would assume, that you would have from STEM to languages, to make sure that you are saying the right things in the right way. So, it's a bit like a problem. It definitely does impact in a sense, in a way that they're, how the two subjects are linked together... ...So, I do think that this link between them both definitely has an impact for me. I actually found that while there are similarities, the way that technology students think about and conceptualise their subject doesn't really change the way I think about French. Because it means I can understand my life and the lives of people around me a lot better. [with respect to technology] I want to change the world. [with respect to technology] I think being bilingual is underrated. Encouraging more students to pick languages so that they can, I suppose, this is sort of quite pragmatic, being bilingual in a multicultural society could be helpful for the future.

Appendix L - School B Phase 1 & 2 Propositions, Technology & Languages (follow-up interviews)

Table 84 School B Phase 1&2 Propositions (follow-up interviews)

Themes	School B – Phase 1 Propositions Identified in Raw data from follow-up interviews	School B – Phase 2 Propositions Identified in Raw data from follow-up interviews	Themes
Group B01 – Languages students		**Group B01 – Languages students, 4 year 10, 1 year 9**	
Culture	Opportunities for more cultural understanding. If we understood their language a bit easier, then we might be able to understand their culture better. If you're really interested in the culture, that will probably inspire you to learn the language	To learn better.	**Learning**
		I think for me it's been quite a big change and I think I've been influenced by what they've been writing, because I think in the last one, I talked a lot about understanding, but now I'm talking more about learning the skills.... I think, yeah, I've been influenced by what the technology students have written. I think I looked a lot closer at the solving and creativity aspects, because before I just talked about understanding and how that can lead to opportunities... ...I talked a bit about connections, but I didn't really think about the solving and creative aspects and how that links together, and then how that links back to the understanding of the language. Because in my first one [concept map] I didn't really think too much about the creative aspect of it, but now after seeing what the technology students brought up, I was like, oh yeah, I like that idea.	**Insight**
Value Perception	We'll have more understanding with them and also opportunities in jobs. So many more opportunities by understanding and learning Indonesian. Even just putting that you've learned Indonesian on your resume would give you better opportunities for good jobs. It just gives you a little more opportunities in that way.	Language is really, it's got so many benefits, because they've both got creative aspects, but just in different ways. I think with language it's different because it's a whole new sort of world when you go into the classroom.	**Value Perception**

Themes	School B – Phase 1 **Propositions** Identified in Raw data from follow-up interviews	School B – Phase 2 **Propositions** Identified in Raw data from follow-up interviews	Themes
Learning	Learning a new language really improves your memory skills. It just expands your knowledge in a range of different ways and not only in just that one subject. I just generally feel like it expands your mind. I think it just expands, I feel like, your brain's function. It just is constantly thinking in a different kind of way to people who don't know multiple languages. I guess it also shows how much we've progressed in learning Indonesian, and I think I find that fascinating.		
Motivation / Aspiration	A big motivation for me because I would like to talk to them in Indonesian.		
Group B02 – Languages students, plus DT Teacher.	**Group B02 – 4 year 10, 3 year 9 Design and Technology.**		
Motivation / Aspiration	Making the world a better place.		
Value Perception	I think the value of design stems from that philosophy that through critical and creative thinking ... the intention is to make the world, the person next to you, whoever it might be, through your design process, a little bit better. But helping others through the design process and I think the value in this subject is that. [languages] can expand the way you can share knowledge. I think the value that design has is that it utilises and integrates ever other learning area. I think the creative process parallels the scientific process because when you break it down, it's about formulating problems, defining problems, testing, creating methodology and solutions that might work. ...where we take out the human focus when we look at STEM all the time and it becomes an engineering course. ...and I think that devalues the notion of an integrated course.	Definitely in the workshop, allows me to be more creative. It makes it easier to learn because it's enjoyable to learn. I don't really know how to explain it. It's just enjoyable to learn in DT, I guess. You are not getting talked at by the teacher. You're actually going out of your way and making something. I think if you're enjoying what you're doing as well, you're more willing to try harder and put more effort into it. [Concept proceeding from proposition: enjoyment] And DT is kind of different from other subjects, because time sort of flies by when you're in the workshop.	**Value Perception**

Themes	School B – Phase 1 **Propositions** Identified in Raw data from follow-up interviews	School B – Phase 2 **Propositions** Identified in Raw data from follow-up interviews	Themes
Insight	I think, to me, learning a language is almost the ultimate form of trying to understand someone else's point of view because it's the way we interact with each other all the time.		
Connection	Because we interact online a lot, it's a lot more important to know other languages in order to experience more.	Design and tech isn't really as connective as languages would be.	**Connection**
Culture	You can never translate something 100% with all of the cultural context.		
Learning	My responsibility to give the students skills and strategies for thinking that they can move beyond or integrate into all areas I disagree with the notion of STEM. I think STEM as a concept oversimplifies the integration. If we really want to integrate all these areas, we have to bring those social sciences and humanities in. IT's less about a list of words and it's more about how those words shape mindsets and attitudes.	DT is very...it's very creative, but it's also very structured. It's just a matter of doing something and designing something that helps it be the best product possible. Because in design and technology, it has heaps of branches and if you really put into the learning, then you can gain benefits, for just in general, and in life. The things you'll learn in DT will generally convert over to like, you can use it in life. And later in life. Provide different perspectives on the problem. Not all problems can be solved the same way.	**Learning**
Group B03 – 6 year 9 Design and Technology students	**Group B03 – 6 year 9 French students 1 year 10 Russian student (via Zoom) Merged with other groups for Phase 2 interviews.**		
Design / Make	It lets me work with my own two hands. Because I get to show my own creativity, and it's a lot less boring than typing on a computer. There's no point researching if we're not going to apply ourselves to that topic. There's no point having something if it's not going to serve some sort of aesthetic or functional purpose in your design. Being unique, being more creative and more hands-on kind of tasks. I would like more freedom in the workshop. Especially in designs, risking in designs and things, although we need more opportunity to create a risky design that might not work, but if it did, it would be really cool.		

Themes	School B – Phase 1 Propositions Identified in Raw data from follow-up interviews	School B – Phase 2 Propositions Identified in Raw data from follow-up interviews	Themes
Insight	I think that the idea of design and the idea of these new technologies, them travelling to these new cultures, I think it encourages a lot of innovation. I think it's important that countries sort of rebound of each other. How they communicate with each other is a big part in technology. I think that design is sort of the language of the future, because right now people are designing things for themselves to make money, not for the world to be better... ...I feel like in the future, design needs to change slightly so it's not looking at the, "Can we make something that's better than everyone else, just so we can make money?" ... ...Can we make things together that will help change the way the world functions at the moment? It kind of gives you a new perspective to look at things from, because design, even though it has all the planning, and it may seem really tedious, it also kind of forces you to think in the way that the person you're making this for might have to think. Like with the empathy part of the design process, that's really important, because it makes you actually get into the issues and think, if I was this person, what would I want from this product.	You can understand those in a different way, and you can think of more solutions to those problems. So language as a pathway to problem-solving [researcher comment] Mm-hmm [endorsed by participant] I think helping other subjects like English about different writing in a different language, it can help you think of how to do that in a different way. So it's not just about knowing and understanding the difference, but experiencing and doing the difference as well [researcher comment] Yes [endorsed by participant]	**Insight**
Value Perception	Language, because in the future, jobs, there's going to be a lot of design jobs. Different opportunities might occur in different places, and it's not always going to be where you are or what language you speak.		
Frustration	Asking us to be really creative and really push the creative boundaries outside of the box, but then they're restricting us with what we can use, the materials we can use, the way we can use it.		
Group B04 – 6 year nine French students		**Group B04 – 6 year nine French students Merged with other groups for Phase 2 interviews.**	
Value Perception	Knowing a language can help you in terms of what occupation you want to choose and where you might end up living at the end of that occupation.		
Culture	If you learn the language, it means you gain more of an understanding on how		

Themes	School B – Phase 1 **Propositions** Identified in Raw data from follow-up interviews	School B – Phase 2 **Propositions** Identified in Raw data from follow-up interviews	Themes
	cultures work and how everything kind of resides in their beliefs... ...It also helps you understand the way they kind of treat their way of life.		
Group B05 – Year 10. Four D&T students, two French students.	**Group B05 – Year 10. Four D&T students, two French students. Merged with other groups for Phase 2 interviews.**		
Design / Make	I think that in D&T there's a lot of trying to think or trying to create a product or design something that people haven't done before, or that's different to what's already been done.		
Motivation / Aspiration	Love for the subjects [Design and Technology] Something that draws me to D&T is like the hands-on. So basically, I like the creativity aspect of languages. Bring out the best of the best from all over the world together to create something with technology and stuff like that is really achievable.		
Culture	I feel that it's formed by culture. I just think that the cultural aspect is very, very different.		
Frustration	Honestly, I would like to see more girls in the STEM area. We bring like a different perspective to it because there are a lot of boys in the STEM rather than girls. It kind of should be equal, I guess. I guess boys are more like sort of stereotypically, like are more into the woodwork and practical stuff.		

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