Fresh Minds for Science: Using marketing science to help school science

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Doctor of Philosophy

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Certificate of original authorship

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

Signature of Student:

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Dedication

I dedicate this body of work to my daughters, Elizabeth and Victoria. They are my love and inspiration and have been the best in-house test subjects a mother could wish for.

Glossary

ACARA	Australian Curriculum, Assessment and Reporting Authority, an independent statutory authority responsible for the development of school curriculum, assessment and reporting
Achievement goal theory	A psychological model based on the idea that goals are a key motivation to learn
ATAR	Australian Tertiary Admission Rank, a score used by tertiary institutions either alone or with other criteria to rank applicants for selection into courses
Attribution theory	A psychological model based on how people attribute meaning to other people's behaviour or their own
BOSTES	The Board of Studies, Teaching and Educational Standards NSW, the NSW Government authority for standards in curriculum, student assessment and teacher quality
BWS	Best Worst Scaling, a survey method in which respondents determine the best and worst option from sets of factors to determine the relative importance of factors affecting a decision
Career indecision	A measure of how sure a student is of their career path
CCA	Constant Comparative Approach, an analysis technique that used to develop a theory from the data collected (grounded theory)
Content analysis	A research technique for making replicable and valid inferences from data to their context
CSIRO	Commonwealth Scientific and Industrial Research Organisation, Australia's national science research agency
DCE	Discreet Choice Experiment, a survey method in which respondents trade-off between scenarios to determine the importance of factors affecting a decision

Environment Phase	The second phase of the Fresh Minds for Science study
Expectancy-value theory	A psychological model based on the theory that behaviour is a function of the expectancies a person has and the value of the goal toward which that person is working
Focus group	A group discussion based on a chosen topic or topics and designed to provide generalised group data
Focus Group Phase	The first phase of the Fresh Minds for Science study
Framing	The ways in which options are described when questions are asked
Fresh Minds for Science	Short title for this study
Fresh Minds	Short title for this study
Generation Z	Those people born 1982-2000 (approximately)
Grounded theory	A social science methodology involving the construction of theory through the analysis of data
Good marks	Student phrase used to indicate academic proficiency in a subject
Government School	School which are operated by the relevant Australian State or Territory government
HSC	Higher School Certificate, the highest educational award school students can gain in New South Wales, Australia
ICSEA	Index of Community Socio-Educational Advantage, a scale created by ACARA for the purpose of identifying schools serving similar student populations
Marketing	An activity that is aimed at exchanging offerings that have value for customers, clients, partners and society at large
NESB	Non-English Speaking Background, a person who has migrated to Australia and whose first language is not English, or someone who is the child of such a person
Non-government school	School that operates under the authority of an Australian State or Territory government but is not operated by a government education department
NSW	New South Wales, a state on the eastern coast of mainland Australia

OECD	Organisation for Economic Co-operation and Development
PISA	Program for International Student Assessment, a triennial survey by the OECD which aims to evaluate education systems worldwide by testing 15-year-old students
Science	Science (capitalised) refers to the school subject or subjects teaching science
Scientific literacy	"The ability to engage with science-related issues, and with the ideas of science, as a reflective citizen" (OECD, 2015)
Semi-structured interview	An interview using a questioning framework but which is open and so allows new ideas to be brought up during the interview
Self-efficacy	The belief that person has in their ability to influence events that affect their lives
Self-efficacy theory	A psychological model based on individual differences in the motive to achieve and on the effects of subjective expectancy on both this motive and the incentive value of success
Social cognitive career theory	A theory that suggests career behaviour is a result of interaction between self-efficacy, goals, and outcome expectation
Temporal discounting	The tendency of people to discount rewards as they approach a point in time in the future or the past
TRA	Theory of Reasoned Action, a behavioural model that predicts behaviour based on a person's behavioural intention
STEM	Science, Technology, Engineering and Mathematics
Survey Phase	The third phase of the Fresh Minds for Science study

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Abstract

The supply of scientists and scientifically literate citizens is vital for Australia's prosperity. However, traditional approaches to inspire Australian children to choose Science in senior school and through to university have been insufficient to meet Australia's needs for scientifically educated individuals. This study, Fresh Minds for Science, attempts to understand how students choose their subjects for study in Years 11 and 12 and how the choice of Science is influenced by this decision-making process. The study was conducted within a marketing and science framework informed by the Theory of Reasoned Action. It employed a mixed methods approach in an exploratory sequential design to examine student career aspirations and perceptions of subject choice. Research was conducted in five schools in the Sydney region. Data were collected and analysed from 10 focus groups with 50 students, interviews with 15 adult stakeholders within schools, and seven subject selection event observations. Findings from this qualitative investigation were used to construct and administer a survey to 379 students. The survey examined student career aspirations, perceptions of subject choice and contained a Best Worst Scaling component to investigate the relative importance of the 21 factors that were found to be considered by students when choosing subjects. The findings indicate that participating students accepted and rejected subjects based on enjoyment, interest and the perceived need for those subjects in their future study or career plans. They saw the principal benefit of studying Science in particular was as preparation for a stereotypical career in science. This study suggests redressing students' narrow perceptions of Science by marketing Science as an empowering and achievable 'purchase' that is valuable for a range of occupations and for life generally. It also recommends that students' perceptions of their own abilities in Science be supported during the critical time in Year 10 at which subject choice is made.

CHAPTER 1: **Introduction**

1.1 Background

Within the Australian school system, Science is compulsory for study until the completion of Year 10. In 1992, over 85% of Australian Year 10 students chose a Science for study in Years 11 and 12. By 2007, that percentage had fallen to 51% and further analysis suggests the participation rate in Science has stabilised at this level (Goodrum, Druhan, & Abbs, 2012; Kennedy, Lyons, & Quinn, 2014; Office of the Chief Scientist, 2012). For many who have found science a valuable and important tool in their lives, the decision of almost half of Australian Year 10 students *not* to study Science is perplexing. The desire to understand why students are not choosing Science and what can be done to improve student participation in Science is the inspiration for this research.

The study of Science in the final years of school is critical because the subject selection decisions that teenagers make influence their potential career paths (Thomson, 2005). Furthermore, our modern society is dependent on science to provide new knowledge, technologies, and solutions to pressing world problems (Ainley, Kos, & Nicholas, 2008; Dobson, 2006; Goodrum et al., 2012; Lyons & Quinn, 2010; Office of the Chief Scientist, 2012; Tytler, 2007). Given the widely accepted benefits of studying Science to the individual and society, it is important to ask why a large proportion of students do not continue with Science when given the choice. The intention of this study is to develop an understanding of the reasons students accept or reject Science by exploring the factors that impact students' subject choice decision making as they prepare for their final years of schooling.

1.2 A fresh approach

Science has played an important part in my life, though for many years I worked in fields other than science. My science degree taught me how to critically evaluate information and to use rigor in the application of that information in varied work situations. Like many science graduates, I left a traditional science role to work in another sector, in my case,

marketing and product management in the finance sector. My science qualification, enhanced by a Master of Business Administration, has served me well in my career.

My investigation of student participation rates in Science began in 2010 when I completed a Bachelor of Teaching in science education. While studying for this qualification, I realised that I could use my specific skills to address the challenge of increasing enrolments in school Science. I investigated what I saw as the alarming downward trend in school Science enrolments and reviewed the substantial work that had been conducted to arrest this trend. This work supported the benefits of science literacy and showed there is strong link between choosing Science at school and a career in science. However, in spite of the widely acknowledged importance of science, technology, engineering and mathematics (STEM) for Australia's future, the interventions attempted thus far to reverse the flow of students away from STEM have not yet succeeded.

Analysis of this flow from STEM led me to consider my standpoint as a science graduate, marketer and teacher as a basis for providing a different perspective on the problem: a marketing perspective. I call my approach Fresh Minds for Science.

Modern marketing is aimed at identifying and fulfilling needs and it has progressively adopted more scientific methodologies since the industrial revolution when mass production and mass consumption changed the ways of Western civilisation (Kotler & Keller, 2012). In addition to scientific methods, marketing has borrowed intensively from sociological, psychological and economic theories to analyse and predict human behaviour and to understand how people make choices (Jones & Tadajewski, 2008).

Marketing research is often used to analyse how customers choose products from the range available to them. Such analysis is insightful because it does not presuppose that there is a problem with the features of the product (or service) that is currently being offered. Customers' perceptions of the value of a product and how that product's attributes meet the needs of the customers are studied from the perspective of a purchase decision. Marketing offers contemporary techniques for choice analysis and strategies that influence subject choice behaviour.

Fresh Minds for Science aims to use some of these techniques and strategies to investigate how students choose their subjects for study in Years 11 and 12 and how the choice of Science, in particular, is influenced by this decision-making process. The proposition is that when students are thoroughly informed about the nature of Science and its value as a subject, they will be drawn to it and choose it willingly.

1.3 Fresh Minds for Science

1.3.1 Research questions

A marketing perspective is one in which the aim is to "attract new customers by promising superior value and to keep and grow current customers by delivering satisfaction" (Armstrong, Adam, Denize, & Kotler, 2014, p. 4). From a marketing perspective the research questions addressed are categorised in three ways: the decision problem, the discovery-oriented research questions and the strategy-oriented research question (Churchill, Brown, & Suter, 2010).

The decision problem is the primary research question and states the broad purpose of the research. The discovery-oriented research questions are aimed at gathering information to assist in understanding the problem and informing decision makers. The strategy-oriented research question frames the outcome of the study with respect to changing customer behaviour.

The research questions developed for the Fresh Minds study are:

Primary research question (decision problem)

- How might more students be influenced to study Sciences in Years 11 and 12?

Discovery-oriented research questions

Decision-making characteristics

- What decision-making process do students use to decide which subjects to study for Years 11 and 12 at school?

- What factors do students consider when choosing their subjects for Years 11 and 12 at school?

- What is the relative importance of the factors that students consider in choosing their subjects for Years 11 and 12 at school?

Environment of choice

- What information are students provided with to assist them in choosing their subjects for Years 11 and 12 at school and how is this information assessed by them?

Perceptions of Science

- What perceptions do students hold regarding the value of choosing Science for the final years of school?

Strategy-oriented research question

- What marketing-informed strategies can be suggested to increase the numbers of students choosing to study Science in Years 11 and 12 at school?

1.3.2 Research approach

The Fresh Minds for Science (Fresh Minds) research design is based on a standard market research design. The study was conducted in three phases utilising a mixed methods approach using an exploratory sequential design (Creswell, Piano Clarke, Gutmann, & Hanson, 2003). The three phases of Fresh Minds are the Focus Group Phase, the Environment Phase, and the Survey Phase. Figure 1.1 shows the relationship between these three phases with arrows indicating where the findings from one part of the study were used to inform subsequent parts.

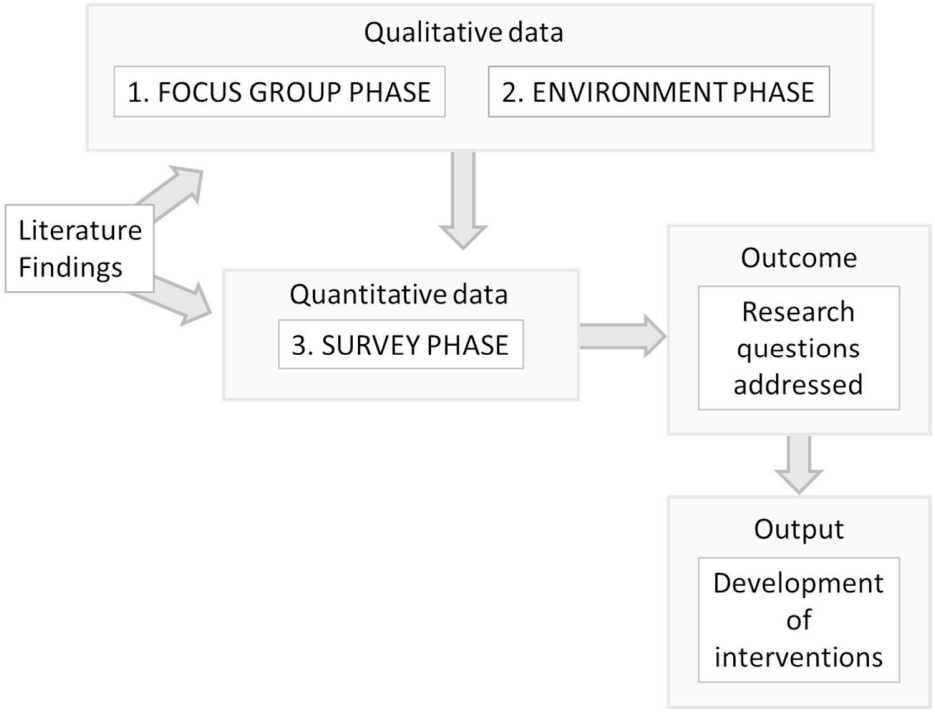

Figure 1.1: The three phases of the Fresh Minds for Science study.

The first and second phases of Fresh Minds are qualitative and are aimed at developing an understanding of how students choose their subjects for study in Years 11 and 12 and the environment within which these choices were made. In the first phase, focus groups were conducted with students in Years 10 and 11 to determine the perceptions and beliefs they held regarding these choices and to develop a view of how subjects were chosen. In the second phase, the written and verbal information students had received to inform their decisions were reviewed and the adults who assisted students with subject selection within the school environment were interviewed.

The final phase of the study used findings from the qualitative component of the study to construct a survey that was administered to Year 10 students at the participating schools. The survey provided data on the relative importance of the factors identified in the qualitative phase that students considered in their decision-making process, the difficulty of

subject choice, the influence of career planning, and how these were related to Science subject choice.

1.3.3 **Scope**

The scope of the study was limited to the key decision period in Year 10 when students choose their subjects for study in Years 11 and 12. Year 10 and 11 students provided information on how subjects were chosen and how these students viewed Science. Both Year groups were studied in order to determine if students provided differing views of their decision-making process before and after making their choices. Adults within the school environment who were in a position to inform students on subject choice were also asked to about their perceptions of how students chose subjects.

The scope of the study is shown diagrammatically in Figure 1.2. The area labelled 'IN' lists the specific areas that are the focus of the Fresh Minds study. The area labelled 'Influencing Factors' shows those factors that lead to the formation of student perceptions and are relevant to the student subject choice decision. These influencing factors are within the scope of this study but are not its primary focus. Items excluded from the scope of this study are labelled 'OUT' in the figure. This study does not consider two factors that may impact student subject choices: socio-economic status, and adults who impact student behaviour and are external to the school environment. These factors were excluded as they represent large areas of enquiry requiring resources not available for this doctoral study. Several other factors that impact on the supply of scientists and scientifically literate people after students leaving school were also excluded.

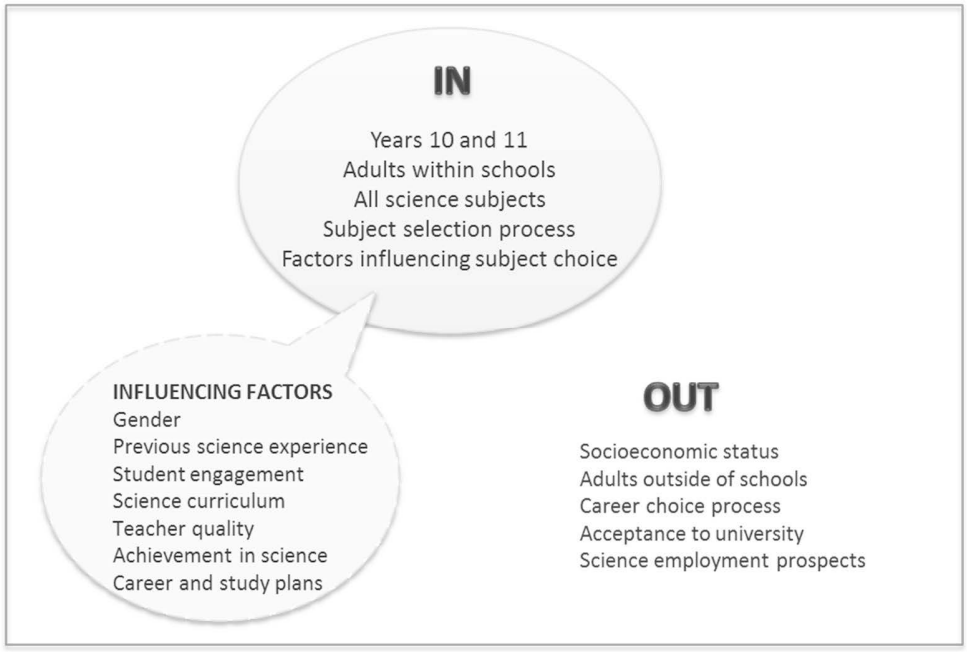

Figure 1.2: The scope of the study.

Fresh Minds was conducted at five schools within a small suburban region in Sydney, Australia. Other schools were not included due to time and human resource constraints.

1.4 Contribution to knowledge

Australia needs its youth to remain engaged in scientific enquiry and to develop scientific literacy. This study combines three distinct disciplines - science, marketing and education - to contribute to knowledge with anticipated practical benefits. The Researcher's skills as a scientist, a marketer and a teacher allows a unique perspective from which to analyse the modern 'customer' of high school Science and the ways this customer makes subject selection choices.

This research is significant as it focusses on the period that students make their final subject selection decision. It explores the factors they consider and who or what influences their decision making. Past research has revealed numerous factors that students consider in their subject selection process, such as whether a subject is enjoyable, difficult, useful, and

who helped them form this judgment (Lyons & Quinn, 2010; Nolan, 2012; Warton & Cooney, 1997; Whiteley & Porter, 1999). Research that asks students about the decision-making they go through at the time they choose their subjects has not been conducted. Consequently, the relative importance of the factors that students consider in making their subject choice decisions is undocumented.

This study asks students to describe how they choose their subjects and how they value Science in this subject selection process. The Best Worst Scaling methodology (Finn & Louviere, 1992) used in this study allows the relative importance of the factors for choice of subject to be quantified. Asking students about how they choose subjects and determining the ranking of the factors for choice allows marketing strategies to be developed that may influence subject choice behaviour with a view to increasing the appeal of Science for study in Years 11 and 12 at school.

1.5 Limitations

The sample used in this study limits the generalisability of the findings presented in this thesis. Students and adults from five schools represented a small geographical area and homogeneous socioeconomic group. Further avenues of study to improve understanding of subject choice are suggested at the conclusion of this thesis.

1.6 Theoretical approach

The marketing approach adopted by Fresh Minds allows the problem of the decline in school Science enrolments to be seen from a new perspective. Students may be viewed as 'customers' and the environment within which they choose their subjects as the 'marketplace' where the selection is made. Such an approach is designed to identify opportunities for changing student behaviour with respect to choice of Science.

The Fresh Minds study utilises the theoretical framework of the Theory of Reasoned Action (TRA) to develop an understanding of student behaviour with respect to subject choice. This theory was chosen as a theoretical framework as it is specifically directed at predicting and changing behaviour. TRA is based on the concept that most behaviours of social relevance are under the direct control of the individual and therefore the best

predictor of behaviour is the person's behavioural intention. This theory is well validated and is directed at predicting and changing behaviour through understanding of the formation of intent to perform a specific action (Fishbein & Ajzen, 2010).

1.7 Structure of this thesis

This thesis is presented in seven chapters. Chapter 1 briefly introduces the study. Chapter 2 presents a critical review of the research literature relating to choice of Science at school and addresses knowledge gaps in this field. This chapter identifies the gap in the knowledge that is addressed in the Fresh Minds study. Chapter 3 outlines the methodology adopted in this study and gives a rationale for the chosen research method. This chapter also includes a discussion of limitations of the study and ethical issues related to the chosen methodology. Chapters 4, 5 and 6 describe respectively the findings of the Focus Group, Environment, and Survey Phase*s* of Fresh Minds. Chapter 7 presents a discussion of these findings and suggests three strategies that respond to the primary research question for this study. This final chapter also suggests further research to expand our knowledge of how students choose subjects at school and how this influences the choice of Science. A reference list and four appendices complete the thesis.

1.8 Summary

Science has been stated as a key driver for Australia's future prosperity (Prime Minister of Australia, Tony Abbott, in Office of the Chief Scientist, 2014). Investment in improving the supply of scientists and scientifically literate individuals needs to be supported by research to ensure that funds are used to best effect. This research is aimed at developing an understanding of a decision point which has a large effect on the flow of scientifically trained people - the choice to accept or reject Science for further study at school.

Fresh Minds for Science considers students as customers, purchasers of Science. This study suggests the choice of Science is an issue of attracting and retaining ‘customers’ to Science at the time subject selection is made. The intention is to attract ‘fresh minds’ to Science through the utilisation of marketing ‘science’ techniques and strategies that present Science to students in ways that address the factors they find important in choosing a subject.

CHAPTER 2: **Literature Review**

2.1 Introduction

Many children become disenchanted with Science when they enter high school and develop a view that the subject is irrelevant and uninteresting (Goodrum, Hackling, & Rennie, 2001). The fall in enrolments in senior Science subjects that has occurred in the past two decades is of concern to educators and policymakers (Goodrum et al., 2012; Office of the Chief Scientist, 2012). When given the opportunity in Year 10 to select subjects for their final two years of schooling, almost half of Year 10 students do not choose a Science subject and instead choose alternative subjects from the wide range of courses available to them (Kennedy et al., 2014, Lyons & Quinn, 2010, 2015). The question of why so many students no longer choose Science remains unanswered.

The need for scientifically trained individuals and scientific literacy in the general public is supported by numerous reports (Ainley et al., 2008; Dobson, 2006; Goodrum et al., 2012; Lyons & Quinn, 2010; Office of the Chief Scientist, 2014). The link between the choice of Science at school and the path into science careers is well established (Ainley et al., 2008; Thomson, 2005). The importance of maintaining and enhancing the flow of scientists and increasing the scientific literacy of the general populace means it is critical to study the decision point at which students choose *not* to continue with Science past Year 10.

This chapter provides an overview of research literature that is pertinent to the choice of Science at school and the impact of this choice on the supply of scientifically educated individuals. This analysis also identifies important gaps in the knowledge relating to the role of the subject choice process in the selection or rejection of Science.

The remainder of this chapter is arranged in five sections. Section 2.2 addresses Australia's need for scientists and science literacy and the importance of choice of Science at school in fulfilling these needs. Section 2.3 analyses research on students' choices regarding Science study at school. Section 2.4 considers subject choice behaviour from the viewpoint of adolescent decision-making. Section 2.5 describes the marketing perspective

adopted by this study and considers the Theory of Reasoned Action, the theoretical framework for this study. The chapter concludes with a discussion of the key points observed in the research literature, the identification of gaps in knowledge regarding subject choice, and the Fresh Minds research questions that address these gaps.

2.2 Need for science and scientists

It is widely acknowledged that Australia needs scientists and a scientifically informed populace to deal with the demands of modern technology, global problems such as climate change and poverty, and to ensure the future prosperity of the Nation (Ainley et al., 2008; Dobson, 2006; Goodrum et al., 2001; Lyons & Quinn, 2010; Tytler, 2007; Office of the Chief Scientist, 2012). The need to improve the supply of human capital with the skills to conduct and commercialise technological change has been stated as the main driver of STEM economic policy in Australia (Australian Workforce and Productivity Agency, 2012; Marginson, Tytler, Freeman, & Roberts, 2013; Office of the Chief Scientist, 2014). Improving scientific literacy is also important as it provides citizens with the necessary skills to understand, evaluate, and make informed decisions regarding complex problems in our technologically advanced society (Fensham, 1985; Goodrum et al., 2001; Woods-McConney, Oliver, McConney, Schibeci, & Maor, 2014). In short, Australia needs to build its scientific capability in order to address current and future social, health, environmental, political and economic challenges.

Australian's Federal and State governments along with those of many other Western nations have been vocal in the need for scientifically educated people and considerable resources have been directed at science education (Australian Government, 2014; Bøe, Henriksen, Lyons, & Schreiner, 2011; Office of the Chief Scientist, 2012; Wang & Degol, 2013). Australia's Chief Scientist, Ian Chubb, stated that there is a global perception that the future success of Australia relies on a substantial proportion of its workforce being educated in STEM (Office of the Chief Scientist, 2014). This view is supported by the Australian Prime Minister, the Hon Tony Abbot MP, who stated, "There will be significant emphasis on boosting our focus on science, technology, engineering and maths because

science is at the heart of a country's competitiveness" (Office of the Chief Scientist, 2014, p. 5).

The importance of science for Australia's economic growth is widely recognised and yet there is concern that Australia's performance is falling (Office of the Chief Scientist, 2012). Australia's scientific human resources are of particular concern as there are fears the country's performance in Science is falling relative to other nations. The performance of Australian 15 year-olds in measures of scientific literacy in the Program for International Student Assessment (PISA) has declined relative to other countries in recent years (Thomson, De Bortoli, Nicholas, Hillman, & Buckley, 2010; Thomson, De Bortoli, & Buckley, 2013).

2.2.1 **Choosing Science at school**

Science is a compulsory subject in Australian schools until students complete Year 10. During this last year of compulsory science instruction, students typically choose five or six subjects from a wide range available to continue into their final two years of schooling (see Appendix A for a summary of The Board of Studies, Teaching and Educational Standards NSW (BOSTES) rules relating to subject selection; NSW, 2011). The study of one or more Science subjects in the final years of school is critical because the subject selection decision that teenagers make has a major influence on the career and tertiary educational options open to them (Thompson, 2005).

Thompson (2005) analysed study choices of the 1998 student cohort from the Longitudinal Study of Australian Youth and found that certain clusters of subjects, when taken together, tend to result in students undertaking further study in specific areas at university. Two of these clusters included Mathematics and physical sciences, and for students taking subjects within these clusters, over 80% entered higher education at university, predominantly in natural and physical sciences, engineering, and health. Combinations of more than one Science subject are a strong indicator of a student's future career pathway into science (Ainley et al., 2008; Thompson, 2005).

Senior study in science not only provides Australia with potential future scientists but also with a scientifically literate community that is seen to be beneficial in its own right (Fensham, 1985; Goodrum et al., 2001; Woods-McConney et al., 2014). According to the OECD (2015), scientifically literate people are those that are "willing to engage in reasoned discourse about science and technology" because they have competency in being able to: explain phenomena scientifically; evaluate and design scientific enquiry; and interpret data and evidence scientifically (p. 7). The Melbourne Declaration by the Ministerial Council on Training, Employment, Training and Youth Affairs (2008, p. 5) states "Australians must be able to engage with scientific concepts and principles, and approach problem-solving in new and creative ways". It has been argued that the main purpose of science education in pre-senior years should be scientific literacy rather than the provision of human capital (Goodrum et al., 2001). The Australian curriculum emphasises the importance of scientific literacy, which states the importance of Science in providing skills for making decisions and participating in society, in addition to school Science providing preparation for scientific careers (ACARA, 2012).

2.2.2 **The supply of science based skills**

The numbers of students choosing to study Science for the final years of school has declined in past decades. The year 1992 represented a peak in enrolments in Science when 85% of Year 12 Australian students chose to study Science (Ainley et al., 2008). In 2010, the percentage of students choosing Science had fallen to 51% (Goodrum et al., 2012). While the fall in senior Science enrolments seems to have stabilised, current levels are still insufficient to provide the science skills to meet Australia's economic and science literacy needs (Kennedy et al., 2014; Office of the Chief Scientist, 2012).

Table 1 shows the participation rate of Year 12 school students within Biology, Chemistry and Physics for 1991 and 2007 as reported by Ainley, Kos, and Nicolas (2008). Although a change in reporting standards in the data sets and changes in school retention rates over this period means the percentages are not strictly comparable, the decrease in participation in these Sciences is significant.

Table 1: Participation of Australian 17-year-olds in Science subjects

Subject	Participation in 1991	Participation in 2007	Change 1991 - 2007
Biology	36%	25%	-31%
Chemistry	23%	18%	-22%
Physics	21%	15%	-29%

The decrease in student enrolments in Science generally and particularly in Chemistry, Mathematics and Physics has led to forecasts of a shortfall in the future supply of scientists (Ainley et al., 2008; Dobson, 2006; Goodrum et al., 2012; Lyons & Quinn, 2010).

2.3 Research into choice of Science at school

Research investigating choice of Science at school has led to suggestions that a range of factors play a role in a student's decision to select or reject Science. Attitudinal studies and studies looking at factors influencing the decision to choose Science have investigated various aspects of Science choice (e.g. Hassan, 2008; Kidman, 2009; Kind, Jones, & Barmby, 2007; Lyons, 2006). Several themes recur in the research literature, and this section provides an overview of those informing the three key themes: logistics of choice, student characteristics, and subject characteristics. These groupings have been chosen as they relate respectively to three areas from which the choice of Science can be addressed by students: the practical considerations of choosing science, the student attributes that influence this choice, and the characteristics of Science as a subject at school.

2.3.1 **Overview of research**

Several comprehensive national reports produced in recent years have examined the issue of student enrolments in Science and factors relating to its decline. These reports include: *Participation in Science, Mathematics and Technology in Australian Education* (Ainley et al., 2008), *Choosing Science* (Lyons & Quinn, 2010), *The Status and Quality of Year 11 and 12 Science in Australian Schools* (Goodrum et al., 2012), and *Mathematics, Engineering and Science in the National Interest* (Office of the Chief Scientist, 2012). These reports provide data and analysis regarding past enrolments in school Sciences and the context within which Science is chosen.

Additional to national reports are a range of studies that address the issue of Science choice in school and the factors that may influence this choice (e.g., Ainley et al., 2008; Danaia, Fitzgerald, & McKinnon, 2013; Elliott & Paige, 2010; Goodrum et al., 2012; Quinn & Lyons, 2011; Tajalli & Opheim, 2005; Thomson, 2005; Tytler, 2007; Wang & Degol, 2013; Westwell, 2007). The factors commonly cited as being major influencers of the decision to choose Science at school are: students' engagement in school Science, their perception of the usefulness of science, socio-economic factors, gender preferences for some Science subjects, and the decreased relative popularity of Science as a subject generally. It has also been suggested that Science has become less appealing as a subject due to competition from the extensive range of non-Science subjects now available within schools (Danaia et al., 2013; Lyons & Quinn, 2010; Lyons, 2006). Further, some students reported that they like Science and intended to choose a Science for further study but were found to change their mind when the subject choice decision was made (Venville, Oliver, Longnecker, & Rennie, 2010). The scope of the research and the list of factors that may impact on students' choice of Science indicate the issue is complex.

The range of factors that is believed to be important in Science subject selection are discussed in the following sections within the three topic areas: logistics of choice, student characteristics, and subject characteristics.

2.3.2 **Logistics of choice**

Choice of subject by students in Year 10 for study in Year 11 is limited by the practicalities of that selection. Australia's states and territories have differing but similar rules relating to the awards that are gained at the completion of schooling. The highest educational award school students can gain within the Australian state of New South Wales (NSW), where this study was conducted, is the Higher School Certificate (HSC) (NSW Government, 2011). Students can choose a limited number of subjects for study in the final two years of schooling (see the summary of HSC rules in Appendix A). Students must choose five or six subjects from the large range of subjects available.

The extensive range of subjects now available in many schools has led to the suggestion that competition from other subjects may result in fewer students choosing

Science (Lyons & Quinn, 2010). Timetabling of subjects for senior students can also mean that some subjects may be unavailable to students. Senior students who have not chosen Science have mentioned timetable clashes as a reason why they chose other subjects (Goodrum et al., 2012).

Not all schools provide all Science subjects for students to study. Harris, Baldwin and Jensz (2005) conducted an Australia-wide study of 219 schools with senior enrolments and found that 80% of the schools offered Biology, Chemistry and Physics in both Years 11 and 12. Within these schools, 88% offered Year 12 Biology, 90% offered Year 12 Chemistry and 87% offered Year 12 Physics. In eight schools (4%) Biology, Chemistry and Physics were not offered at all. A lack of demand for the Science subjects was the most common reason given by these schools for Science subjects not being offered. These statistics suggest that although Science is not available to all students, some Science subjects are available for study at the majority of Australian schools.

2.3.3 **Student characteristics**

Research shows that although school-related variables play an important role in the ability of students to obtain an Australian Tertiary Admission Rank (ATAR) required for university entrance, there is a stronger influence resulting from a student's individual characteristics than those relating to their school (Gemici, Lim, & Karmel, 2013). Science subject choice is influenced by factors outside the school such as family socio-economic status, and exposure to science outside of the school environment (Aubusson, Griffin, & Kearney, 2012; Bennett & Hogarth, 2009; Lyons, 2006; Lyons & Quinn, 2010). While each of these factors is considered to play a role in students' orientation towards Science, the nature of this role is uncertain.

This section discusses the impact of student characteristics on the choice of Science and is organised into five themes for discussion: family and peers, gender, attitudes and interest, and self-efficacy.

Family and Peers

There is a strong association between the choice of Science and socio-economic factors (Ainley et al., 2008; Fullarton & Ainley, 2000). Students from poorer socio-economic and non-English speaking backgrounds are less likely to choose Science than those from more affluent families and those where English is a first language (Ainley et al., 2008). Adolescents whose parents worked in a profession are also twice as likely to choose Chemistry or Physics subjects as those whose parents had unskilled or semi-skilled occupations (Fullarton & Ainley, 2000).

Peers are an influence on adolescent behaviour with an important period of peer influence occurring during the ages of approximately 12 to 16 (Ryan, 2000; Stanrock, 2010). Students are typically age 16 when choosing their subjects for Years 11 and 12. As Ryan (2000) suggests, because schools are inherently social environments, peer groups are believed to influence students' beliefs and behaviours with respect to academic achievement at school. Studying the effect of peers on students' scholastic motivation at school presents methodological and conceptual challenges. Observing the interaction of students within their peer groups is difficult. Although the more general effects of peer groups on scholastic achievement remain uncertain, Ryan (2000) notes that students who are in academically-oriented peer groups are more academically successful.

Gender

Gender-based preferences for some Science subjects may be an important factor affecting choice of Science at school (Ceci & Williams, 2007; Dobson, 2006; Kessels & Taconis, 2012). Rebalancing the gender mix in some Science subjects has been posed as a strategy to improve the numbers of students taking Science (Quinn & Lyons, 2011).

Within Australia, male and female students have differing subject choice preferences with respect to Science (Ainley et al., 2008; Thompson, 2005). Male students appear to have a slight preference for Chemistry and female students show preference for Biology. With respect to Physics, the gender bias towards males is significant. This bias is thought to be due to basic differential preferences in the genders rather than a specific result of teaching practices (Thomson, 2005). Females prefer working in areas that will self-

evidently help people such as Biology and health rather than the enabling sciences (Physics and Chemistry), which are perceived as leading to non-traditional roles for women (Dobson 2006).

The quest to explain why gender differences exist when students are choosing Science has made this topic the subject of numerous scholarly papers and books (e.g., Ceci & Williams, 2007; Cousins, 2007; Elsworth, Harvey-Beavis, Ainley, & Fabris, 1999; Mack & Walsh, 2013; Mujtaba & Reiss, 2012; Quinn & Lyons, 2011; Wang & Degol, 2013. Much of this research has been directed at understanding why more girls do *not* choose Science. Why there are gender preferences for certain Science subjects continues to be a main area of interest in science education (Office of the Chief Scientist, 2012).

Attitudes and interest

Students' attitudes to different aspects of science have been supported as a key component in understanding the decline in students choosing Science (Osborne, Simon, & Collins, 2003). Attitudes towards science have been extensively researched over many years (e.g., Ainley & Ainley, 2011; Crawley & Koballa, 1994; Jenkins & Pell, 2006; Osborne & Collins, 2001; Sjøberg & Schreiner, 2012). However, the components of attitude and differing tools to measure it create an unclear picture of how attitudes towards science have changed in past decades (Blalock, Lichtenstein, Owen, Pruski, Marshall, & Toepperwein, 2008; Tytler & Osborne, 2012).

The concept of interest has been used to understand why students engage or withdraw from certain themes or contexts in science education (Krapp & Prenzel, 2011). Interest is thought to evolve from an individual's interaction with his or her environment in both the affective and cognitive domains (Hidi & Renninger, 2006). According to Krapp and Prenzel (2011), attitudes and interests may be viewed as synonymous or alternatively, interest may be considered a form of attitude. The development of personal interests (defined as the motivation to pursue and objective) are believed to be strongly related to subject choice and subsequent vocational choice (Elsworth, Harvey-Beavis, Ainley, & Fabris, 1999). Interest is discussed further in the next section in the context of self-efficacy and ability.

There are concerns that some attitudinal investigations in the past regarding falling interest in science may be unreliable as they have not employed rigorous psychometric factors (Blalock, et al., 2008). Notwithstanding this limitation, students are believed to hold different attitudes to different aspects of science. The Norwegian based Relevance of Science Education (ROSE) study (Sjøberg and Schreiner, 2005) is an ongoing study involving approximately 40 countries aimed at gathering and analysing information from the 15-year-olds about their attitudes motivation with respect to learning science and technology. According to Tytler and Osborne (2012) the two main findings from this study are that there has been decreasing interest in science in more industrialised countries and that girls expressed more negative attitudes towards science than boys. Although students have generally positive attitudes to studying Science at school, there is some agreement that this attitude is declining in Western societies (Barmby, Kind, & Jones, 2008; Potvin & Hasni, 2014; Tytler & Osborne, 2012).

However, students' attitudes towards Science and scientists and their enjoyment of the subject are not significantly different from those expressed by students two decades ago when Science enrolments were high (Lyons & Quinn, 2010). Further, studies in psychology have found that the link between attitudes and behaviour is tenuous (Maio & Haddock, 2009). The relationship between attitudes and behaviour is uncertain and is discussed further in the context of adolescent decision-making in section 2.4.1.

Self-efficacy and ability

An individual's perceived self-efficacy is the belief that person has in their ability to influence events that affect their lives, motivation, emotional well-being, and accomplishments (Bandura, 1982, 1997). The beliefs adolescents have about their abilities influences their choices as well as their lives (Bandura, 2006). By mid to late adolescence, students are likely to form an enduring interest in activities they see themselves as competent in and expect to receive valued outcomes from (Brown & Lent, 2006). Interests and self-efficacy are closely linked as interests are strongly predicted by self-efficacy beliefs and by outcome expectations (Brown & Lent, 2006). It has been argued that in making the choice about whether to study Science, there is an interaction among students'

interests, attitudes, self-efficacy, and conceptual beliefs held of science and scientists (Christidou, 2011; Goodrum et al., 2012).

Research into scientific interest has indicated that interest and achievement are related and that students' academic success in a subject is likely to lead to an interest in that subject (Brown & Lent, 2006; Kidman, 2009). Prior performance in Science and Mathematics play a role in choice with a strong association between the choice of Science and achievement in Mathematics (Ainley et al., 2008). Students who perceive that they lack ability in Science state this is a reason for not choosing to study Science in Years 11 and 12 (Ainley et al., 2008; Lyons & Quinn, 2010). There is also evidence that students may not choose Physics and Chemistry because these subjects are perceived by students as being difficult (Ainley et al., 2008; Kessels & Taconis, 2012; Lyons & Quinn, 2010).

2.3.4 Subject characteristics

The characteristics of Science as a subject and the way it is taught are both believed to influence students in their choice of Science. This section discusses the influence of teaching and curriculum on Science choice and the impact of career aspirations on that choice.

Teaching and curriculum

Teaching quality has been suggested as an important factor in the future study choices of students generally (Office of the Chief Scientist, 2012; Tytler, 2007). Science teaching in particular has been criticised for remaining unchanged for decades - utilising transmissive, traditional teaching techniques that conflict with the needs of modern students (Goodrum et al., 2001; Tytler 2007). If students see classroom Science as uninteresting and difficult, there may be a negative effect on their interest, self-efficacy and attitude towards the field and therefore their choice of a Science subject (Christidou, 2011; Goodrum et al., 2012).

The curriculum for Science in Years 11 and 12, according to Goodrum et al. (2012) has been content laden and difficult – directed principally at preparing students for university study in science. These researchers have suggested that students' decisions to study Science are based on both their experience in lower secondary school and their future

aspirations. The new Australian Curriculum attempts to address these issues of content and difficulty in order to provide students with the appropriate skills and knowledge required for a broad range of careers (ACARA, 2012). However, as this new curriculum is still being implemented, its effect on student subject choice may not be evident for some years.

Careers

The subjects students choose to study in their final years influences the career and study options open to them (Boe et al., 2011; Thomson, 2005). The choice of Science in particular is an important decision point on the path to a STEM-related career. There is concern that school students may not choose Science because they are unaware of the diversity and nature of science-related careers (Goodrum et al., 2012; Lyons & Quinn 2010). Several authors argue that increased knowledge of the relevance of a science degree, and a more authentic understanding of the nature and practicalities of being a scientist, may improve the perception of science as a career (Tytler & Osborne, 2012; Lyons & Quinn, 2010; Rodrigues, Tytler, Darby, Hubber, Symington, & Edwards, 2007).

Providing students with a more informed view of scientific careers is already an area of intervention through the Scientists in Schools project developed by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) which aims to provide scientists as mentors, role models, and inspiration for students (CSIRO, 2007). Lyons and Quinn (2010) stated that students' difficulty in seeing themselves as a scientist was stated as a factor for why students do not choose Science. However the role of career considerations in subject choice is not clear as students in Lyons and Quinn's study who had chosen Science only slightly agreed with the statement that career was a consideration in their choice.

According to social cognitive career theory, students tend to be drawn to career paths involving activities in which they are most interested (Brown & Lent, 2006). The higher a student's self-efficacy in their academic studies and perception of their ability to perform occupational roles, the broader the range of potential occupations they will consider (Bandura, 2006). However, there is only a weak correlation between interest in science and a career in science (Athanasou, 2001).

Many adolescents show periods of indecision before choosing their career paths and the relationship between career decision-making self-efficacy (the assessment a student makes of their ability to undertake the tasks to select a career) and career indecision (how sure the student is of their career path) is complex and indistinct (Creed, Prideau, & Patton 2006). A study examining the career indecision in a group of 155 Australian students over the period from Year 8 to Year 10 revealed counter to expectations, that changes in career decision-making self-efficacy did not result in changes in career indecision (Creed et al., 2006). Another study of 925 Australian students between Years 8 and 12 showed that although adolescents may be unsure of a career path, they generally aspired or expected to work in a small range of occupational vocational types (Holland, 1997; Patton & Creed, 2007).

The link between career and the subject choices students make is important, yet there is considerable indecision among Year 10 students regarding career choice at the time they are making subject decisions for Years 11 and 12 (Nolan, 2012). Analysis of career advice given to student in schools revealed that it is provided in an equitable manner and that students are generally satisfied with the information they receive and find it useful (Rothman & Hillman, 2008). However, the degree to which a student considers such career advice when choosing subjects is uncertain.

Senior students have reported that they chose Science to meet university prerequisites and to maintain their career options. The study by Goodrum et al. (2012) aimed at understanding the status of Years 11 and 12 science in Australian schools included a survey of 1157 students who had chosen Science and 363 who had not chosen Science. This survey asked students in a free-response question why they had or had not chosen Science. The analysis revealed that although a few students said that they chose Science because they enjoyed it, most students stated they chose Science to meet prerequisite requirements set by universities. Some students who had not yet chosen a career stated that they chose Science because they wanted to keep their study options open. The most common reason cited by students for not choosing Science was that they disliked Science or found it boring (61%). Almost a third (31%) stated they choose not to do Science because it was hard to understand or they did not perform well in the subject. Twenty-six

percent of students not choosing Science indicated that made this choice because they did not need Science for their careers.

The next section outlines current research into how adolescents make decisions and how their decision-making behaviour relates to subject choice.

2.4 Subject choice behaviour

The behaviour of students with respect to subject choice is not well understood. As discussed in the previous section, there has been significant research on subject choice. However, students' stated intentions regarding choosing Science do not necessarily correlate to their actual behaviour. In a study of 174 students in Western Australia by Venville et al. (2010), substantially fewer students chose Science than those who indicated that this was their intention. There was a gap in the intention stated by students and their actual behaviour regarding subject choice. The students who had indicated their intention to choose a Science subject stated that their major reason for this choice was that they liked Science and thought they would do well in Science.

2.4.1 **Adolescent decision making**

Adolescence is a complex developmental period with physical, hormonal and neurological changes influencing behaviour in an environment that challenges adolescents with increasing information loads and performance demands (Crone 2009; Sowell, Thompson, Leonard, Welcome, Kan & Toga, 2004). There has been significant research in the field of adolescent judgment and decision making in the past decade (Albert & Steinberg, 2011). From mid-adolescence through to adulthood there is little change in information processing or logical reasoning yet adolescents' behaviour and decision making are quite different from adults (Albert & Steinberg, 2011; Crone, 2009; Santrock, 2010).

Most decisions (adult and adolescent) are based on a suite of cognitive and affective biases and heuristics that may or may not be supported by logic (Albert & Steinberg, 2011). Rational choice behaviour is poorly supported by empirical findings (Abelson, 1995; Stanovich, 2013), yet a pervading mindset exists that we must justify our reasons on rational rather than expressive grounds. Indeed, the ways in which questions are asked

about behaviour (called 'framing') appear to influence responses as people seek to both rationalise the decisions they have made and make choices based on the manner in which the question is asked (Shafir, 1993; Tversky & Kahneman, 1986, 1991). In other words, if students are asked whether they chose Science because they needed it for a career, they may agree because they interpret this as an acceptable response to a researcher who has asked that specific question. The student's response is framed by the question even though they may not have chosen a career path or even considered their career needs.

Adolescents vary from adults in their decision-making processes in three important ways. First, they have increased sensitivity with respect to rewards and social information, meaning adolescents show lower ability than adults in regulating their behaviour and emotional responses in social environments (Silvers, McRae, Gabrieli, Gross, Remy, & Ochsner, 2012). Second, there is a less developed level of cognitive control available to suppress impulsive behaviour (Blakemore, 2003; Crone, 2009). Third, in the adolescent timeframe there are high levels of temporal discounting, which means adolescents have a preference for short-term gains even though these may be of lesser value than long-term gains (Whelan & McHugh, 2009). Notwithstanding these differences, most adolescents show excellent decision-making competence, and contemporary researchers now regard this decision making as unique to adolescents rather than simply the operation of an incomplete adult brain (Albert & Steinberg, 2011).

Attitudes toward studying Science at school decline to age 14 and then increase through to age 16 (Bennett & Hogarth, 2009), the typical age of a Year 10 student selecting subjects for Years 11 and 12 at school. This change in attitude towards Science occurs at a pivotal time in the development of an adolescent's brain, when neurons are being reorganised and life-long preferences are being set and plans made (Sowell et al., 2004). If there is a link between attitudes towards studying Science and choosing Science for study in the final years of school, then interventions during this important time period may be effective in improving the perception of Science.

The next section outlines the marketing perspective adopted for the Fresh Minds study and the theoretical framework that underpins it.

2.5 Theoretical foundation

2.5.1 **Marketing perspective**

Marketing is an activity that is aimed at exchanging offerings that have value for customers, clients, partners and society at large (Elliott, Rundle-Thiele, & Waller, 2010). Customers make purchase decisions based on which offering is seen to deliver the most value. Marketing is aimed at delivering value by identifying the value to the customer, providing that value, and communicating the value with a view to creating profit for the company (Kotler & Keller, 2012; Armstrong et al., 2014). The Fresh Minds study adopts a marketing perspective to provide a unique perspective on the issue of students choosing Science at school.

Modern marketing practice is not directed at 'selling' products to customers. Indeed, marketing has been used by benevolent organisations such as the Red Cross to 'brand' their organisations and to help people more easily recognise an organisation's benefits (Moroko & Uncles, 2009). Marketing techniques are powerful and known to be successful with children and so particular care must be taken to avoid convincing children to make inappropriate choices (Le Guay, 2003).

The current generation of students choosing subjects at high school are the first to grow up in a world with the internet and are termed 'Generation Z' (born 1982 – 2000, Australian Bureau of Statistics, 2005). Bandura (2007, p. 2) suggests modern teenagers live in an "electronic era of rapid social and technological change that is transforming how people communicate, educate, work, relate to each other and conduct their business and daily affairs".

According to Ivanova and Smrikakov (2009), the characteristics of individuals in a generation are shaped by the technologies available to them and by the social and cultural values of the society in which they matures. Generation Z are identified as having strong opinions, being poor listeners, individualistic, and independent – driven by fun and having little regard for social norms. Education and career is much less important to Generation Z children than their parents.

Generation Z adolescents are influenced by different factors than their parents and the generations before them. Although descriptions of generations tend to present the more challenging aspects of the generation as viewed by older generations, it is important to consider these teenagers as individuals (Schuck, Aubusson, Buchanan, & Russell, 2012). When marketing to teenagers, they are thought to prefer to be treated as individuals who care about their world and receive their information from a 'friend' (Elliott, Rundle-Thiele, & Waller, 2010).

In order to understand how to market to teenagers who are Generation Z, it is useful to understand them as customers as well as the market in which they live (Kotler & Keller, 2012). Market research allows decision makers to understand how customers value products, the markets in which they make their purchase decisions, and the nature of those decisions (Malhotra, Birks, & Wills, 2012). Researching how students value Science compared to other subjects and the decision making they use to choose subjects allows strategies to be developed to market Science to Generation Z 'customers'. This marketing perspective views the choice of subject as a purchase decision made by a unique demographic with the specific aim of increasing student perception of the value of Science and changing behaviour so that more students will choose to study it.

2.5.2 **Predicting and changing behaviour**

In addressing the problem of students not choosing Science, previous research in education has generally focused on the motivation behind a student's choice and why decisions have been made (e.g., Ainley & Ainley, 2011; Barmby et al., 2008; Hassan, 2008; Kidman, 2009; Lyons & Quinn, 2010). In particular, the research has analysed attitudes to Science and how these are influenced by such things as past experiences in Science, the way the subject is taught and who has provided guidance to students (Lyons & Quinn 2010, Ainley et al., 2008, Goodrum et al., 2012).

More generally, the efforts to explain motivation have been based on a range of theories including attribution theory (Weiner, 1985), self-efficacy theory (Bandura, 1977), achievement goal theory (Atkinson, 1978; Urdan, 1997), social identity theory (Gee, 2000), and expectancy-value theory (Eccles et al., 1983). The last of these, expectancy-value,

"focuses on individual differences in the motive to achieve and on the effects of subjective expectancy on both this motive and the incentive value of success" (Eccles et al., 1983, p. 79). It is arguably the most popular psychological model that seeks to explain the choice of Science at school (based on a literature search by the Researcher).

Expectancy-value theory incorporates elements of other commonly used behavioural theories used in the field of science education. However, this theory is focused on providing a framework to explain the behaviour of individuals, whereas the marketing focus of this study calls for a model directed at predicting and changing behaviour. Of the models available, the Theory of Reasoned Action (TRA) was chosen as the theoretical framework for this study because the TRA is designed to explain behaviours with the aim of predicting and, if desired, changing those behaviours.

Theory of Reasoned Action

The TRA has been developed over the past 45 years from the theory of planned behavior, expectancy-value theory and a range of other motivational and behavioural theories (Fishbein & Ajzen, 2010). The main tenet of the TRA is that the best predictor of behaviour is the person's behavioural intention. This is because most behaviours of social relevance are the under direct control of the individual (Fishbein & Ajzen, 2010). The theory suggests that an individual's beliefs about how well they will do in an activity and how much they value that activity will explain their choices of, persistence at, and performance of, those activities (Eccles, 2009; Wigfield, 1994; Wigfield & Eccles, 2000).

Expectancy-value theory was originally developed over 50 years ago by Martin Fishbein, who later became one of the researchers who incorporated it into the TRA (Eccles & Wigfield, 2002; Eccles 2009; Fishbein & Ajzen, 2010; Wigfield, 1994). Several other social-cognitive theories also used in education and marketing have similarly been incorporated into the TRA in an attempt to create a unified theory to define intent and predict subsequent behaviour. These include self-efficacy theory (Bandura, 1993, 1997) self-identity theory (Rise, Sheeran, & Hukkelberg, 2010), attribution theory (Weiner, 1985, 2000), and achievement goal theory (Atkinson, 1978; Urdan, 1997).

The TRA is a simplified form of the theory of planned behavior (TPB). The difference between the two theories is that the TPB includes the additional determinant of intention of 'perceived behavioural control' which is based on an individual's control beliefs. The TRA assumes that people have control over the behaviour of interest in which case 'perceived behavioural control' becomes irrelevant (Armitage & Conner, 2001). The model for the TRA is show in Figure 2.1. This model shows the proximal antecedents to the intention to behave are attitudes towards the behaviour and subjective norms. The attitudes toward the behaviour are based on behavioural beliefs regarding the outcome and how that outcome is evaluated. Subjective norms toward the behaviour are based on the normative beliefs relating to what others think and what experts might think.

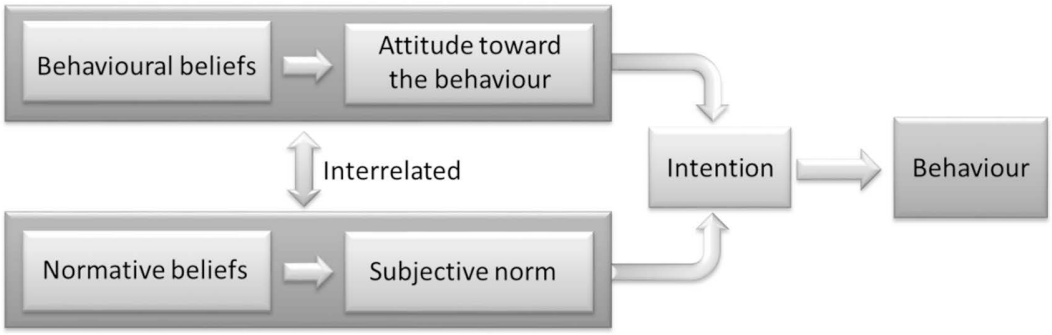

Figure 2.1: The Theory of Reasoned Action.

Empirical validation. The TRA has been used in a broad range of research studies and is often used in customer behaviour research (Fishbein & Ajzen, 2010). Armitage and Connor (2001) found evidence to support the efficacy of TPB through analysis of 185 independent studies published up to the end of 1997. These studies examined behaviours in areas such as leisure, sexual risk, health, and ethics. Cooke and French (2008) conducted a meta-analysis of 33 TPB/TRA studies predicting medical screening attendance and found that the TRA/TPB was an effective framework for predicting screening intentions and attendance. Sheppard, Hartwick, and Warshaw (1988) conducted two meta-analyses on studies utilising

the TRA to understand a wide range of behaviours and found strong evidence for the validity of the models. The strength of this theory lies in this high level of validity, the incorporation of other theories into the design, and its focus on directly predicting behaviour through the analysis of intention rather than concentrating on motivators. The TRA provides an appropriate framework for this trans-disciplinary study in the fields of education and marketing.

The TRA has been utilised in educational research to investigate the choice of science at school. Stead (1985) investigated the use of TRA to investigate New Zealand students' intentions regarding Science choice. The theory was found to successfully understand and predict the intentions of these students and this paper highlighted the utility of the TRA in the field of Science Education Research. The TRA has been used to study girls' intentions to enrol in at least one physical science course in high school (Koballa, 1988) and the intentions of grade 8 students' to enrol in a high school science course (Crawley & Coe, 1990 as cited in Crawley & Koballa, 1994). The TRA was used to develop a measurement instrument to determine the effect of messages designed to encourage high school chemistry enrolments for Hispanic American students (Crawley & Koballa, 1992) and to understand and predict Korean high school students' choice of sciences verses humanities subjects (Myeong & Crawley, 1993). A literature search did not reveal other studies in the past two decades utilising the TRA to understand Science choice at school. Reviews by other researchers into Science subject choice and science attitudes that refer to the TRA (Osborne et al., 2003, Tytler & Osborne 2012) do not reference recent studies using the theory. Stead (1985, p.85) suggested, "Ajzen and Fishbein's 'theory' provides both an instrumental technique for collecting requisite data and an explicit rationale for allowing for the analysis, description, prediction and application of the findings generated." This study utilises the valuable and well validated framework of the TRA to investigate subject choice by modern students.

A further description of the TRA and a discussion of the impact of the TRA on the methodology chosen for Fresh Minds is discussed in section 3.2.1.

2.6 Summary

The selection of Science by students in their last years at school is recognised not only as a key step in the supply of future scientists but also as an important factor in increasing the level of scientific literacy in the community. If a student does not choose a Science subject, the probability of that student pursuing science at a tertiary level is very low. Choosing Science is a key step on the pathway to increased scientific literacy in the community and increasing the supply of scientists. Developing an understanding of the factors that affect the decision to select or reject Science is the focus of this study. This chapter positions the Fresh Minds study in the context of a range of studies in the area of Science subject choice over past decades.

Two decades of research aimed at understanding and increasing the level of participation in school Science are yet to translate into increased enrolments in Science. Although such increases may come in time, it would be prudent to continue looking for innovative ways to impact on students' decisions regarding Science as a field of study. Fresh Minds utilises a marketing perspective directed at evaluating students' perceptions of the value of Science to better understand the subject choices students make and how these choices may be influenced. This understanding is underpinned by the TRA, a validated model for the prediction of behavioural intention, which is seen as the main determinant of behaviour.

Fresh Minds focuses on the time period within which students make their subject selection decision; the factors they consider; and who, or what, influences them. Past research has revealed that numerous variables are considered by students when choosing or rejecting future study in Science. This study builds on this research to examine the subject choice decision factors that may influence student choice behaviour toward the taking of Science.

The next chapter provides a description of the methodology for this study.

CHAPTER 3: **Methodology**

3.1 Introduction

This study was directed at answering the primary research question: How might more students be influenced to study Sciences in Years 11 and 12? A mixed methods approach was chosen to gather information about how students choose their subjects for their final years of school with the objective of understanding how this choice process affects the selection of Science. This chapter provides a description of the methodology employed in each phase of the Fresh Minds study and rationale for the choice of a mixed methods approach.

This chapter comprises seven sections. Section 3.2 outlines the research design for Fresh Minds and contains a rationale for the chosen research design and a discussion of its theoretical and epistemological underpinning. Section 3.2 ends with an overview of the study. Sections 3.3, 3.4, and 3.5 describe the methodology employed in each of the three phases of the Fresh Minds study. Section 3.6 provides a discussion of the risks, ethical considerations and limitations of the chosen methodology. The chapter concludes with section 3.7, which summarises the key features of the Fresh Minds methodology.

3.2 Research design

3.2.1 **Theoretical positioning**

Fresh Minds employed a mixed methods approach within a marketing focused framework. This section discusses the theoretical suitability of these methodological approaches to answer the research questions:

- How might more students be influenced to study Sciences in Years 11 and 12?
- What decision-making process do students use to decide which subjects to study for Years 11 and 12 at school?

- What factors do students consider when choosing their subjects for Years 11 and 12 at school?
- What is the relative importance of the factors that students consider in choosing their subjects for Years 11 and 12 at school?
- What information are students provided with to assist them in choosing their subjects for Years 11 and 12 at school and how is this information assessed by them?
- What perceptions do students hold regarding the value of choosing Science for the final years of school?
- What marketing-informed strategies can be suggested to increase the numbers of students choosing to study Science in Years 11 and 12 at school?

Table 2 provides an overview of the three phases of Fresh Minds. For each phase it shows the sample groups, the purpose, the research instrument used, and the data analysis method.

Table 2: Overview of the three phases of the Fresh Minds study

Study phase	Sample Groups	Purpose	Research instrument	Analysis methods
Focus Group Phase	Year 10 & 11 students	To understand student perceptions of subject choice	Focus groups	Comparative analysis
Environment Phase	Subject choice resources at schools Adults at schools	To understand environment within which subject choice is made	Observations Interviews	Content analysis Comparative analysis
Survey Phase	Year 10 students	Obtain rich data on subject choice: Student perceptions and choice factor rankings	Survey with multiple-choice, free-response, interval-scale, and BWS components	Comparative analysis Statistical analysis BWS analysis

Mixed methods research designs combine quantitative and qualitative procedures to collect and analyse data within a single study for the purpose of "gaining a better understanding of the research problem" (Ivankova, Creswell, & Stick, 2006, p. 3). In this study, mixed methods were chosen for two reasons. First, when quantitative and qualitative methods are used in combination, the strengths of both methods complement each other and allow more robust analysis of data in determining results (Ivankova, Creswell, & Stick, 2006). Second, the mixed methods research design allowed not only the qualitative identification of factors influencing decision making but also the quantification of the relative influence these factors upon the subject choices that students make.

Neither qualitative nor quantitative research alone was considered sufficient to answer the research questions posed for this study (Creswell & Plano Clarke, 2007; Silverman, 2013). To investigate student subject choice, this study employed an exploratory sequential design (Creswell et al., 2003; Ivankova et al., 2006). This design involved three stages within a single study. The first stage (Focus Group and Environment Phases) was the collection and analysis of qualitative data. In the second stage (Survey Phase) quantitative data were collected to gain further understanding of the results obtained in the first stage. The results from each stage were then integrated in the third stage and conclusions drawn in order to answer the research questions.

In designing the study, consideration was given to issues of priority, implementation, and integration of the quantitative and qualitative approaches (Ivankova et al., 2006). Priority is concerned with which of the quantitative or qualitative components of the research has more weight or whether they were of similar value. Within Fresh Minds, both qualitative and quantitative phases were designed to generate unique insights into subject choice and were considered of equal priority.

The implementation of an exploratory sequential design meant the qualitative and quantitative phases were conducted in sequence, with the first qualitative component designed to gain an understanding of the process students used in choosing subjects and the factors they considered in their decision making. The quantitative phase then sought to

provide in-depth understanding of subject choice and determine how the decision-making factors were ranked by students.

The integration of qualitative and quantitative findings was made at the interpretation stage of the study. Findings from both phases of the study were combined in the discussion of the study, thereby allowing a more detailed view of the research problem and thus more robust answers to be developed in response to the study's research questions.

Marketing focus

The marketing focus means that data were collected to understand 'customer behaviour' with respect to subject choice with the objective understanding and increasing student perceptions of the value of Science. The mixed methods approach was formulated within a marketing focus. The research design incorporates market research methods that would be used by businesses to assist in marketing decision making (Wilson, 2012; Churchill et al., 2010). Market researchers use techniques familiar to the social sciences but collect data with the specific purpose of identifying and increasing the perception of the value of a product or service to the customer (Keller & Kotler, 2012). The approach adopted within Fresh Minds was designed to determine how students value Science as a subject 'purchase' by understanding the process students use to select their subjects and the factors that influence their decision making.

Marketing researchers collect primary and secondary data to understand customers and markets. Primary data are collected to meet the needs of a specific market research project and secondary data are collected by the market researcher for other purposes (Malhotra et al., 2012). The primary data collected in Fresh Minds through a mixed methods approach directed at understanding how subjects are chosen at school and how Science is perceived as part of this process. The research instruments of focus groups, surveys and observations are methods commonly used in market research studies (Wilson, 2011). The literature review presented in Chapter 2 constitutes secondary data for this study as it provides general information on students' choice of Science.

An overview of the research approach used in the Fresh Minds study is presented in Figure 3.1. The outermost circle represents the methodological approach of mixed methods

and within this sits the theoretical framework, the Theory of Reasoned Action, which informs all stages of the Fresh Minds study. The three triangles represent the data sources for the study, with arrows indicating that the qualitative phases inform the quantitative phase. These layers culminate in the generation of new knowledge through the analysis of all three phases the study.

Figure 3.1: Overview of the Fresh Minds methodological approach.

The Theory of Reasoned Action

The choice of Science at school has been investigated extensively within an educational framework utilising a range of behavioural theories. Adopting an alternate approach perspective is an effective way to allow new knowledge to be generated on a research topic being investigated (Frodeman, 2010). This study adopts a marketing focus that is supported by the theoretical framework provided by the TRA (see Section 2.5). The TRA has been utilised in a range of research fields including education (Crawley & Koballa, 1994;

Osborne et al., 2003) and is a well validated model for the prediction of human social behaviour (Ajzen, 2011).

According to Fishbein and Azjen (2010), the TRA evaluates attitude as it affects an intention to behave in association with perceived normative pressure in performing the behaviour. It examines an individual's beliefs that are formed from a range of background factors relating to the person themselves, their social environment and the information they receive. The background factors inform behavioural and normative beliefs. These beliefs generate attitudes and perceptions specifically directed at the intention to perform a defined behaviour.

Although attitudes can be related to behaviour, this correlation is not universal as people with similar attitudes to a given action can behave in very different ways (Fazio, Chen, Mcdonel, & Sherman, 1982; Fishbein & Ajzen, 2010). The TRA focuses on the proximal antecedents of a person's behaviour and treats general attitudes as a background factor that may or may not impact upon a given behaviour. When studying the relationship between attitude and behaviour, the TRA stresses the importance of evaluating the attitude to the specific behaviour of interest (Fishbein & Ajzen, 2010; Maio & Haddock, 2009). Attitudes are often an area of particular interest in education research and although attitudes are still important within the TRA, they are seen as background mediating factors in the formation of intention.

The TRA's emphasis on intention and behaviour is suitable for evaluating how adolescents choose their subjects. Within the marketing perspective of Fresh Minds, the aim is to increase student perception of the value of Science to change behaviour so that more students will choose Science. Using reports on students' attitudes to Science study or descriptions of how students rationalise their choices (Jones & Tadajewski, 2008) are unlikely to be good predictors of behaviour. The TRA allows the relationship between students' intentions with respect to subject choice and choosing Science to be investigated by determining student attitudes towards subject choice and their subject choice intentions.

The methodology for this study was designed to investigate the antecedents to the formation of an intent to choose subjects for study in the final years of school, in particular,

Science. Figure 3.2 shows how the phases of the Fresh Minds were designed to develop an understanding of the factors that influence student behaviour within the TRA framework.

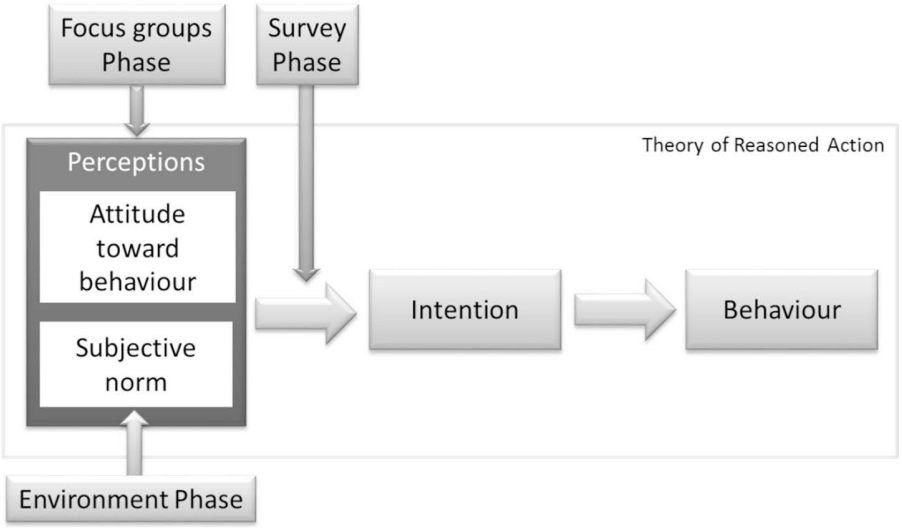

Figure 3.2: Relationship between Fresh Minds methodology and the Theory of Reasoned Action.

Analysing behaviour within the TRA framework helps to address the difficulty in using students' more general attitudes to science to understand and predict whether students will choose to study Science. The focus group component of the study sought to determine the positive and negative factors that students consider when forming an intention to choose or reject certain subjects. Student beliefs in the two key areas of attitude towards the particular behaviour, and social norms around that behaviour, were determined in the Focus Group Phase of the study through specific questioning.

Questions in the focus group component of the study were designed to determine students' perceptions and attitudes regarding choosing subjects for study in the final years of school. Students were asked about the individuals who influenced them to understand perceived norms regarding subject choice behaviour. As well, they were also asked about

their perceptions of their control over the choices they make to determine if perceived control was a factor in their decision making.

The development of student beliefs is impacted upon by the information they receive. This was explored in the Environment Phase of the study, which investigate the written and verbal information given to student to inform their subject selection decision making. This phase also collected interview data from the key adult stakeholders involved in the subject selection process. The information students were provided with and the opinions presented to them from these adult stakeholders allowed the development of a view regarding the environment within which students choose subjects.

The analysis from the Focus Group and Environment Phases, in association with findings from the literature, resulted in a list of 21 factors that were considered to influence the beliefs of students with respect to subject choice. The survey instrument utilised in the Survey Phase contained multiple-choice, interval-scale and free-response questions further exploration of student perceptions of the subject selection process.

The TRA also impacts upon the timing of sampling. The timing of sampling was directed at identifying the actual antecedents affecting choice rather than those may students attribute to their decision at a later time. The TRA is focused on the proximal antecedents to the behaviour. As a result, students were asked about their subject choice deliberations as close as possible in time to when the subject choice decision was being made. This proximal sampling was also chosen to minimise the effect of post-decision rationalization (Shafir, 1993; Tversky & Kahneman, 1986, 1991).

The next sections provide an overview of the features of the qualitative and quantitative methodologies used in Fresh Minds. Further details of the methodology for each phase are presented in Sections 3.3, 3.4, and 3.5.

3.2.2 **Qualitative research phases**

The qualitative component of the Fresh Minds study was conducted in two phases: the Focus Group Phase and the Environment Phase. An interpretivist epistemology was used within these phases (Creswell, 2014; Mackenzie & Knipe, 2006). In an interpretivist

research framework, the views of participants are paramount in the situation being studied, while the impact of the researcher's own experiences on the research study is acknowledged (Holloway, 1997).

The qualitative phases involved collecting open-ended information through focus groups with the student participants and interviews with adult participants to analyse the factors related to subject choice. The Environment Phase also involved both the analysis of documents relating to subject choice and the observation of subject choice events.

A focus group methodology was chosen as this study sought to develop new understanding of student perceptions of subject choice and focus groups are suited to the creation of novel theories (Ashbury, 1995; Krueger & Casey, 2009). A focus group is a group discussion based on a chosen topic or topics and designed to provide generalised group data (Whitney, 2005). Focus groups are designed to gather opinions that allow researchers to understand how people feel and think about a product, service or issue (Krueger & Casey, 2009; Churchill et al., 2010). Focus groups have been successful with middle school students although problems of encouraging quieter members to speak and uneven dominance structures within groups have been cited (NSW Commission for Children and Young People, 2005; Whitney, 2005).

Focus groups were conducted with Year 10 and 11 students at four schools. Respondents were chosen purposefully such that their experiences would be insightful and relevant to the discovery-oriented research questions for this study (Bogdan & Biklen, 1998). Respondent selection is discussed in Section 3.3.1. A constant comparative approach was used to analyse focus group data to determine the factors students considered in decision making and how these relate to student characteristics (Glaser & Strauss, 1967). By investigating relationships to be found from the data rather than working from a hypothesis prior to analysis, this approach allowed factors to be identified and models of behaviour to be posited (Glaser & Strauss, 1967; Glaser, 1992; Maykut & Morehouse, 1994).

This study sought to gain knowledge of student perceptions of subject choice and thus focus groups with students were the first stage in data collection. Previous work on

teenager's choices regarding decisions on whether to choose or not choose to study Science had first determined adult views about these choices and used these views to formulate a questioning strategy for students. In '*Choosing science'* (Lyons & Quinn, 2010), teachers were asked their opinions of how students chose subjects and these data were used as the basis for construction of survey questions for students. In '*The status and quality of Year 11 and 12 science in Australian schools'* (Goodrum et al., 2012) the student questionnaire was developed by the research team with focus groups held after the collection of survey data in order to validate the findings. This Fresh Minds study, by contrast, uses student views as the primary source of information on student behaviour.

After the focus groups were completed in the first phase of the study, the Researcher interviewed the selected adults within the school environment in order to gain their views of students' perceptions of subject choice. Section 3.4 provided details of the interviews conducted. Interviews are an important tool in qualitative marketing research (Carson, Gilmore, Perry, & Gronhaug, 2001). In-depth or multiple interviews were not possible due to the limited access to adults within the school environment. Face-to-face semi-structured interviews (Bernard, 1988) were chosen as an alternative method to obtain the data required. To create reliable and comparable qualitative data, the interview questions were open-ended and allowed for information to be sought specifically on adult perceptions of student subject choice. As with the focus groups, qualitative data obtained during interviews were analysed thematically using a constant comparative approach (Glaser & Strauss, 1967; Glaser, 1992). This analysis allowed an understanding of the factors these adults believed students considered when choosing subject and the advice they might give to students regarding subject choice.

To gain further understanding of the environment within which subject choice was made, the Researcher attended subject selection events within the school environment. Subject selection events are described in Section 3.4. Content analysis was conducted on the field notes and documents resulting from these events in order to infer how these events are perceived by students. Content analysis is "a research technique for making replicable and valid inferences from data to their context" (Krippendorff, 1989, p. 403). These

inferences were contrasted with the student perceptions of these events expressed in the focus groups.

The two qualitative phases sought information about how students chose their subjects and how the perceptions and beliefs held by students influenced these choices. The qualitative phases, in association with findings from the literature, led to the development of a subject selection model and a list of factors students considered important in their subject selection decision.

3.2.3 **Quantitative research phase**

The final stage of Fresh Minds study utilised findings from the Environment and Focus Group phases of the study in concert with findings from similar studies to construct a survey that was administered to students. This survey contained a qualitative component in the form of open-ended (free-response) fields but was primarily composed of closed-ended questions designed to produce data that would contribute to understanding of the factors identified in the qualitative component of the study.

The survey was administered to Year 10 students at five schools. The survey's qualitative components used free-response questions and the quantitative components used multiple-choice, interval-scale, and Best Worst Scaling (BWS) questions. The interval-scale, multiple-choice and free-response questions were designed to further investigate the influence of career planning, choice of subject, and choice of science in particular. BWS was used to provide insights into the choices students made with respect to subject choice survey by allowing extension and validation of findings from the qualitative stage of the study.

BWS (also known as Maximum Difference Scaling or MaxDiff) allows the relative importance of factors involved in a decision to be determined. The method was first described by Finn and Louviere (1992) and is based on random utility theory (Thurstone, 1927; McFadden, 1974). Random utility theory assumes that the frequency with which a person chooses one option over another is a function of their preference for each of the options. These options are the factors that a person considers in their decision-making

process and BWS makes use of the relative preference for factors to understand how a person makes their choice.

BWS assumes that a person is assessing the factors that make up a decision in a subjective manner. That is, each factor (for example, the difficulty of a subject in the case of subject choice) is being appraised by the decision maker as being more or less important than the other factors impacting the decision. By presenting respondents with sets of factors in specific combinations and asking them to select the most and least important from each set, statistical analysis can reveal a hierarchy of relative importance of these factors in the decision making. The method has a strong mathematical basis and is well validated (Louviere, Lings, Islam, Gudergan, & Flynn, 2013; Marley & Louviere, 2005).

BWS has been utilised to understand how choices are being made in a variety of areas including health, public food safety and company ethics (e.g., Burke, Eckert, & Davis, 2014; Finn, & Louviere 1992; Lancsar, Louviere, & Flynn 2007; Lancsar, Louviere, Donaldson, Currie, & Burgess, 2013). At the time of writing, BWS had been used in a single education study on the retention of effective early career teachers (Burke, Schuck, Aubusson, Buchanan, Louviere, &, Prescott, 2013). Fresh Minds is the first study to use BWS as a methodology to understand how students choose subjects at school.

3.2.4 **Validity and reliability**

This section evaluates the methodology of the Fresh Minds study in terms of validity and reliability. Validity is the extent to which research accurately measures what it was intended to measure and reliability is the accuracy of the measurement methods or the confidence one holds that the results are a representation of the population being studied (Golafshani, 2003). A research instrument is considered reliable if the results of a study can be reproduced using a similar methodology. Reliability is a necessary condition for validity but insufficient in itself as results may reliably represent the population but not be valid if the results are not truly answering the research question posed.

Validity and reliability are assessed differently for qualitative and quantitative research. The validity of quantitative data in this study assessed using the typical criteria for

judging qualitative research: reliability (internal and external), validity (internal and external), and objectivity (Creswell & Plano Clarke, 2007). In qualitative research the difficulty in measurement of observable, measurable facts means these measures of validity and reliability are inappropriate (Golafshani, 2003). In qualitative research, measures of validity and reliability are related to the participants and the researcher (Creswell & Plano Clarke, 2007; Golafshani, 2003; Krueger & Casey, 2009; Lincoln & Guba, 1985).

Lincoln and Guba (1985) suggest four criteria for judging qualitative research that better reflect the underlying philosophical perspectives of qualitative research. These are related to the four means of evaluating quantitative research as indicated in Table 3.

Table 3: Validity measures for qualitative and quantitative research

Measures of validity and reliability	
Quantitative research	Qualitative research
Internal validity	Credibility
External validity	Transferability
Reliability	Dependability
Objectivity	Confirmability

The rationale for the validity of the methodology for the qualitative and quantitative components of the Fresh Minds study is discussed in this section.

Qualitative research phases

Although qualitative studies treat reliability and validity, these terms are not viewed separately in qualitative research (Golafshani, 2003). Instead, the validity and reliability of the qualitative component of the study is assessed for trustworthiness using the dimensions of dependability, credibility, confirmability, and transferability (Lincoln & Guba, 1985). Dependability is providing evidence that the findings are consistent and can repeated. Confirmability is the extent to which the findings are shaped by the respondents and not the researcher's bias. Credibility is the confidence that the researcher has that the findings represent the truth. Transferability is the degree to which research results have applicability in other contexts.

Strong dependability is assessed by critical evaluation of both the process of the inquiry and the coherence between the data obtained and their analysis (Lincoln & Guba, 1985). Strong dependability can be confirmed by an independent auditor who critically examines the processes used to generate and support the findings of a study. Although no independent audit has been conducted on this study, the methodology and analysis were reviewed during each stage of the study by an expert in qualitative research. The data collection and analysis were carried out using rigorous methods that were fully documented and reviewed. The data were collected and analysed in a systematic manner to generate findings that are consistent with the data.

The assessment of credibility and confirmability is linked to dependability. The credibility of the research relates to the ability of the study to provide convincing evidence. Credibility can be established through triangulation using multiple methods to collect data on the phenomenon of interest (Lincoln & Guba, 1985; Patton, 1999). Studies that use a single method are more vulnerable to errors associated with that particular method, for example, the use of biased interview questions. Studies that can use multiple methods allow cross-data validity checks (Patton, 1999). Triangulation also reveals inconsistencies in findings across different kinds of data that can identify additional information on the phenomenon being investigated (Patton, 1999).

Triangulation may be seen as a test of validity. However this is contentious as it assumes that weaknesses in different methods will compensate for one another and that results from different sources are comparable (Lincoln & Guba, 1985). Instead, triangulation as used in the Fresh Minds study that allowed the Researcher to be confident that results were comprehensive and well developed.

The Fresh Minds study used two sorts of triangulation, ‘methods triangulation’ and ‘triangulation of sources’ as strategies to reduce systematic bias in the data and assure the consistency of findings generated by differing data collection methods (Patton, 1999; Denzin, 1989). Methods triangulation within this study involved comparing data collected through the focus groups and the survey. These qualitative and quantitative methods were found to produce similar findings for the subject choice phenomena being investigated.

There were sufficient points of divergence within the data produced by the different methods employed to suggest the findings are rich and comprehensive. Within Fresh Minds, the quantitative methods and qualitative methods were also used as a form of comparative analysis. Qualitative and quantitative data were combined to elucidate complementary aspects of the same phenomenon (Patton, 1999). The combination of focus group data, survey free-response and interval question responses answers afforded multiple opportunities for respondents to express views on the phenomena under investigation. The comparison of similarities in responses contrasted with areas of difference provided confidence in the results obtained.

Triangulation of sources allows a researcher to examine the consistency in information provided from different data sources employing the same method (Patton, 1999). This sort of triangulation compares and cross-checks the consistency of information derived from different groups of participants Fresh Minds found that students in different schools were found to express similar viewpoints. The triangulation from different groups of students gives confidence that there is low systematic bias in the data.

Confirmability is the confidence that a study represents the views of respondents and not the bias of the researcher. It is established through rigorous data collection and analysis. The Fresh Minds study was conducted in a systematic manner and records of data collection were maintained with Excel and Word software. The clear audit trail (Lincoln & Guba, 1985) and thorough transcript analysis using NVIVO and Excel software means the results may be verified.

Transferability is the degree to which qualitative research findings can be generalised to other settings (Lincoln & Guba, 1985). The study was restricted to schools in a small geographical area with high socio-economic status. This limits the generalisability of findings outside of this setting, although these results may be generalised to students in schools similar to those participating in the study.

The soundness of the qualitative research conducted in Fresh Minds was discussed in this section. Although validity and reliability are not considered a major factor in qualitative research (Creswell & Plano Clarke, 2007; Golafshani, 2003), Fresh Minds' use

of expert supervision, triangulation, and rigorous analysis, suggest that the qualitative results from this study are trustworthy.

Quantitative research phase

The validity of the quantitative component of the Fresh Minds study was assessed in relation to internal validity, external validity, reliability and objectivity (Creswell & Plano Clarke, 2007). The internal validity is the confidence that the effects shown in the data are causal. As mentioned earlier, the BWS methodology has been well validated as a method of determining the relative importance of factors in decision making (Louviere et al., 2013; Marley & Louviere, 2005).

The external validity of the study is limited because the sample has been drawn from only five schools and for some of these schools only a small subset of students chose to complete the survey. This means the sample is unlikely to represent the population of Year 11 and 12 students in Australia but may be representative of schools similar to those in the sample.

The reliability is the consistency of the results achieved from a study and the confidence that these results are repeatable. The repeatability of the results obtained from the Fresh Minds survey cannot be assessed statistically as it did not undergo a test/retest and the BWS format is not suitable for a test for internal consistency using a tool such as Cronbach's alpha. Notwithstanding this, confidence in the reliability of the findings is improved by the survey's sample size and repetition with different groups of students, thus reducing the chance of abnormal responses skewing the group results. The Fresh Minds BWS survey was the first of its kind to be conducted with adolescents in an education setting. Therefore, although this technique is well validated in a number of fields (Louviere et al., 2013; Marley & Louviere, 2005), at this stage it is not possible to assess the reliability of these survey results with other similar studies.

It would also be possible to test the validity of the BWS component of the Fresh Minds study by evaluating if the BWS results allow the real choices of students to be predicted accurately. This was not possible within the time and resource limitations of the study.

Objectivity is the confidence that the findings represent the truth unbiased by the researcher. In order that the Researcher was not influenced by adult views of subject choice within schools, focus groups were conducted with students prior to adult interviews. The focus groups and interviews were conducted by a single Researcher and, although efforts were made to be rigorous in the moderation of the events, there is a risk that the views of that Researcher may be reflected in the findings. Researcher bias was minimised in the quantitative phase of the study by collecting data through an online survey based on questions generated from multiple sources during the qualitative portions of the study.

Combining qualitative and quantitative data

The mixed methods approach was assessed in terms of the validity of conclusions drawn from the overall analysis of the study's qualitative and quantitative data resulting from the study (Creswell & Plano Clarke, 2007). Threats to the validity of the mixed methods approach were minimised by drawing samples for the qualitative and quantitative components of the study from the same population. Similar and contradictory results from the study's phases were examined closely. Validity was increased by rigorous data analysis in each phase. Qualitative themes identified through systematic analysis of the transcripts were utilised to create the quantitative research instrument.

Having now described the methodological approach taken in each phase of the Fresh Minds study, the next section will provide an overview of the study generally.

3.2.5 Overview of the study

The overview of the study provided here includes information relating to the timing and sampling for the three phases of the study.

Research timeline

All data were collected in 2013, except for three of the 15 adult interviews that were conducted in early 2014 because some individuals were not available until then. Figure 3.3 shows the timeline for the Fresh Minds study.

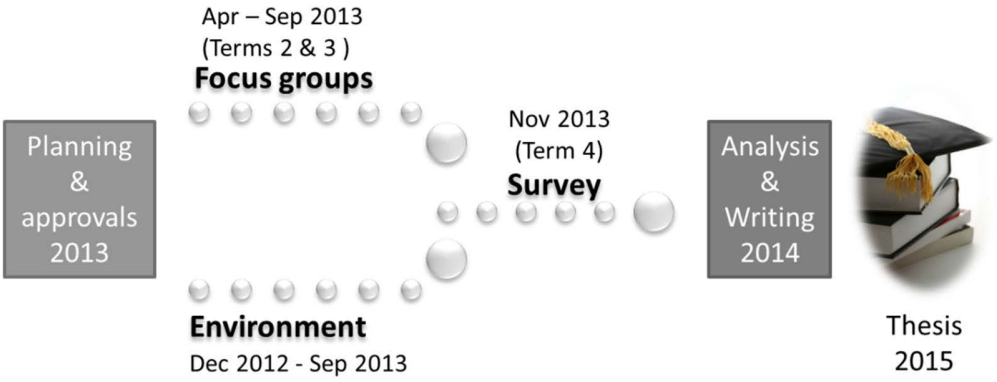

Figure 3.3: Timeline for the Fresh Minds study.

Timing

Focus groups for the Year 11 participants were held during 2013 academic year at times convenient to the schools. The Year 10 focus groups were conducted to coincide as closely as practicable to the time students received subject selection information and were considering subjects for Year 11. For four of the five schools subject choice occurred in term three. Students at one school had chosen their subjects early in 2013, prior to agreeing to participate in the study.

Adult stakeholders were interviewed after the focus groups had been conducted. This timing was chosen to improve confirmability of the study by reducing the risk that the focus group moderator (the Researcher) would develop biases regarding subject choice based on the adult discussions. It was important that the focus groups be a forum for gathering student views rather than validating adult preconceptions.

The survey was conducted as soon as possible after the focus groups were conducted and the results analysed so that the process of subject selection was still foremost in the minds of students. Because the results of the focus group were required to produce the survey, the focus groups were commenced in term two and continued into term three, with the survey constructed and administered to the Year 10 groups of all participating schools in term four.

School selection and management

Five schools in metropolitan Sydney, Australia, participated in this study. Four of these schools provided data in all three phases of the study. Approval from the fifth school's internal ethics committee was not received in time for the school to provide focus groups but the school was able to participate in the Environment and Survey phases.

The schools were selected using the Australian Government's "My School" directory (www.myschool.edu.au), which includes information on the socio-economic environment of each school through its Index of Community Socio-Educational Advantage (ICSEA). Socio-economic status is reported to be a key factor in a student's choice to participate in Science (Anderhag, Emanuelsson, Wickman, & Hamza, 2013; Woods-McConney et al., 2014). As socio-economic status was not a focus for the study, in an attempt to control for this variable the schools chosen had similar above-average ICSEA scores. School ICSEA values are calculated by matching school student addresses to government socio-economic status census data (Australian Curriculum, Assessment and Reporting Authority, 2013). The median ICSEA value calculated for Australian Schools is 1000 (standard deviation (*SD*) = 100) (www.myschool.edu.au). All five schools participating in Fresh Minds had IC*SE*A values above 1100 (one *SD* above the mean) with the average ICSEA value for the five calculated as 1256 (*SD* = 31; calculated using 2012 ICSEA values from the My School directory website).

The average number of students at the five schools was 1203 (*SD* = 255), although two of the schools included primary school students in their enrolment figures. The schools chosen had differing gender mixes and were within a geographic range that made it practicable for them to be visited repeatedly by a single researcher.

Three of the schools chosen for the study were government schools - a girls' school, a boys' school, and a co-educational school. The other two schools were non-government girls' schools (one of which did not participate in the Focus Group Phase). Another school that was initially contacted did not agree to participate

All the five selected schools were contacted and briefed on the key elements of the study. Each provided a representative to coordinate the study within the school. In three

cases this representative was a deputy principal, in the fourth it was the Head of Science and in the fifth it was the head of senior school. Each school representative was informed of the details of the study and provided with a booklet outlining the key elements of the study and the participant requirements. They were also given access to additional information through the study's website (www.freshmindsforscience.weebly.com). Schools were provided with a 'School Process Cheat Sheet' to guide them through participation in the study. The sheet included key points on the commitment required from the school and included the data collection diagram shown in Figure 3.4, which summarises the data collection and reporting sequence for each schools. The student consent was included at the beginning of the online survey and required agreement before students could commence the survey. The information provided to schools also included fact sheets, information sheets, and participant consent forms as presented in Appendix B.

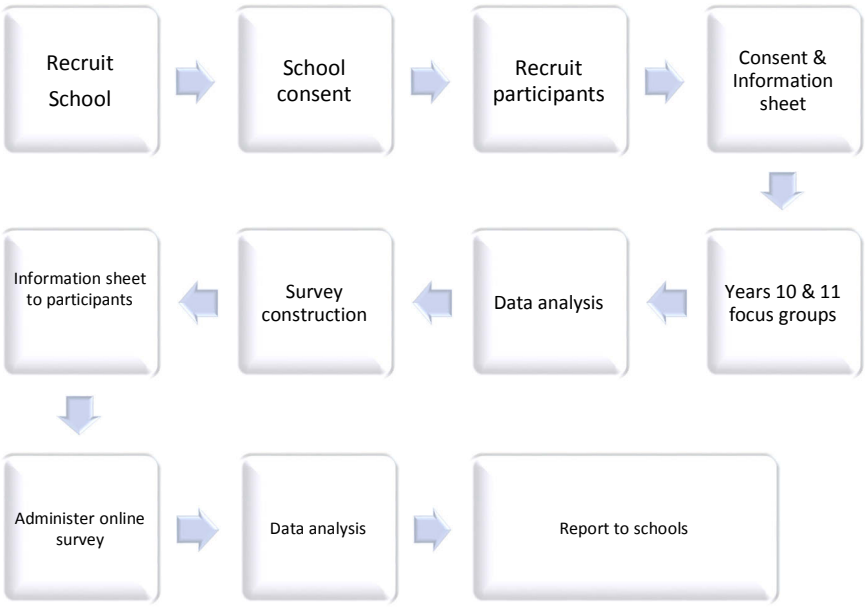

Figure 3.4: Data collection sequence for schools.

The participating schools were also asked to provide Science subject choice data for their Year 10 students after these students' subject selections were made. Science subject choice

data, including enrolment numbers in each Science, were subsequently provided by four of the schools. Two of these schools figures were also provided on the number of students studying two or more sciences subjects. These data are included in the Chapter 5.

Student and adult participants were selected from within the five selected schools. Students participated in the Focus Group and Survey phases of the study. Adults participated only in the Environment Phase. Focus groups were conducted with a purposive convenience sample of 50 students (10 groups) in Years 10 and 11 from four of the five participating schools. Interviews were held with 15 adults from participating schools. The survey was administered to all Year 10 students at all five of the participating schools.

The rationale for the sample sizes chosen for the Focus Group and Survey phases is shown in Table 4, which shows that 96 focus group participants were recommended for this study. The sample size of 383 was the number of Year 10 survey respondents required to enable the survey results to be generalised to the Year 10 population in NSW with a 95% confidence level. This sample size was calculated using the calculator available at the Australian Bureau of Statistics' *National Statistical Service* website (http://www.nss.gov.au/nss/home.nsf/pages/Sample+size+calculator).

Table 4: Rationale for sample selection

Sample type	Calculation (and rationale)	Participants in sample
Focus group	4 schools x 2 year groups x 2 groups of 6 students. Initial group plus follow up on decision making (Krueger and Casey, (2009) recommend 3-4 per type of category)	96
Survey	Total population of Year 10 (2010) [1]	88,104
Required sample size	Confidence interval of .05, estimated proportion of population with attribute of .49	383
Mean Year 10 size	Student number in Year 10/number of schools	104
Sampling frame	5 schools x 104 students	520

[1]NSW Department of Education and Communities, 2011

The actual samples for this study were 50 students participating in the focus groups and 379 students commencing the survey.

The next sections describe methodology for each of the three phases of the Fresh Minds for Science research study.

3.3 Focus Group Phase

The first stage in data collection was to conduct focus groups with students to develop an understanding of the factors that impact on students' subject choice decision-making process and their decision to, or not to, choose Science.

Details of findings relating to the Focus Group Phase are outlined in Chapter 4.

3.3.1 Sample selection in the Focus Group Phase

Purposive sampling of the school students for the focus groups was intended to generate data from students who were thought likely to have considered choosing Science carefully. It was believed these students who had considered Science would talk about a range of factors that influenced their decision to, or not to, choose Science. Focus groups were conducted with students from Year 10 (age 15-16) and Year 11 (age 16-17). School representatives were asked to provide two groups of six students from both Years 10 and 11 to participate in the focus groups. Only the Year 10 students who were achieving a passing grade in Science were acceptable participants for the study. It was considered unlikely that failing students would choose Science as a subject for future study and so their opinions on choosing Science were not sought. For the Year 11 focus groups, school representatives were asked to provide focus groups with equal numbers of students who had chosen Science and who had "surprised their teachers by not choosing Science". Due to timing constraints related to availability of students for the groups, the actual samples provided by the schools varied from the purposive sample requested.

Table 5 shows that 10 focus groups were conducted with 50 students, of these there were 26 girls and 24 boys; 15 government school students and 35 non-government school students; 31 Year 10 students (six focus groups) and 19 Year 11 students (four focus

groups). The final column of the table shows the proportion of students in the Year 11 focus groups who did or did not choose Science. As already mentioned, in the government co-educational school the Year 10 students had already made their subject selection and although all of these participants had not chosen Science they were identified by their teachers as high achievers in Science.

Table 5: Student participants in the focus groups

School type	Sex	Year group	Participants	Science /No Science students
Government	Female	10	5	-
		10	5	-
Government	Mixed	10	5 (3 Female, 2 Male)	0/5[1]
Non-government	Female	10	6	-
		11	5	4/1
		11	2	1/1[2]
Non-government	Male	10	4	-
		10	6	-
		11	6	3/3
		11	6	4/2[2]
Totals: 4 Schools		10 Groups	50 Students	12/12 Science/no Science

Notes.
[1]Students at this school had already made their subject selection.
[2] Includes a student who had chosen a Science but dropped the subject in Year 11.

3.3.2 **Data collection in the Focus Group Phase**

Questions and methodology for the Fresh Minds focus groups were developed utilising a standard framework (Krueger & Casey, 2009). The focus groups were held on school grounds in a room allocated by the school and each focus group was closely monitored to ensure all students' views were heard. Students were withdrawn from class or pastoral care time to participate in the focus groups. Each group ran for 30 to 40 minutes (excluding setup) and began by setting ground rules to encourage open communication. Focus groups were audio recorded and the recordings were transcribed for analysis.

At the commencement of each focus group, the Researcher assured participants of the confidentiality of their responses and briefly informed them about the research with the following statement:

> This research is to find out how students choose Science as a subject at school. I am interested in finding out how you and your fellow students made a decision either to, or not to, study Science as an elective. I want to know your opinions and your experiences and am interested in understanding what runs through your minds when thinking about subject choices.

Participants were first asked to state their names and, as a warm up exercise, to say their favourite subjects, the subjects they did not like, and whether they had decided to study Science. The Researcher encouraged students to speak generally about subject selection and about choice of Science.

The guiding questions for the Year 10 focus groups were:

- Do you already have an idea of what subjects you will choose for next year?
- Walk me through the sort of things you will think about or thought about when choosing your subjects.
- How hard is it to choose subjects? Was it difficult to decide what to do? How important is it? Who are you listening to? What are you looking at?
- What sort of factors did you think about to make your decision?
- How do you decide what subjects you'll need for your career or future study?
- Do you think you will choose Science? Why?
- Do you feel that you've been well prepared for your decision?
- Do you think you are being well informed about subject choice and what it means?

The guiding questions for Year 11 focus groups were:

- Was it difficult to decide what to do?
- Walk me through the sort of things you considered in choosing your subjects.
- Looking back, are you happy with your choice of subjects? (Particularly Science)
- Do you think you were well informed when you made your decision?

- What factors did you use to make your decision? How did this compare with what you were told?
- Who or what influenced you?
- Did you choose Science? Has it met with your expectations? or Did you consider it? What did you choose instead?

The questions formed the basic structure of the focus group discussion and as these discussions progressed, the questioning expanded to investigate emerging themes in more detail and to probe students' reasoning behind their statements. Some participants voiced disagreement or were seen to make expressions suggesting an alternate view. If there was an indication of disagreement, these issues were explored when they arose in order to determine how each member of the focus group considered them.

The Researcher concluded each focus group by asking participants: "Is there anything that I need to know but have not asked" and "what do you think should be done to encourage more students to choose Science".

3.3.3 **Analysis in the Focus Group Phase**

Data obtained through focus groups were analysed using NVIVO (version 9.2). This software is recognised as valuable for analysing qualitative data such as these to identify relationships and to allow important factors affecting student decision making to be identified (Wilson, 2011). The software facilitated open coding using a constant comparative approach to systematically identify concepts (called nodes in NVIVO) and their relationships from the data, rather than proposing these categories prior to analysis (Glaser & Strauss, 1967; Glaser, 1992; Maykut & Morehouse, 1994).

Individual participants were not identified in the focus group transcriptions. For consistency, the audio recordings and transcripts were coded and analysed by a single Researcher (the author) and coding reviewed with education academics. The software package NVIVO was used to code focus group discussions and initially involved listening to focus group recordings several times to identify the broad themes in the discussions. These themes became the initial concepts (nodes) set up within the software for initially

coding of the transcripts. As the transcripts were examined, the identification of further nodes led to the creation of a structure of interrelated nodes within NVIVO, each containing pertinent participant statements extracted from the transcripts. Statements were coded to multiple nodes if they related to multiple themes. This constant comparative approach allowed identification of broad and specific themes and, through the analysis of common coding, their relationships (Maykut & Morehouse, 1994).

NVIVO analysis tools were used to run enquiries on the nodes in order to investigate relationships between nodes and measure frequencies of responses on particular topics. Details of the nodes generated by analysis of the transcript data and NVIVO analysis metrics are reported and discussed further in Chapter 4.

3.4 Environment Phase

In order to understand the environment in which students choose subjects at school, the Researcher attended school subject selection events, collected information, and interviewed adult stakeholders within schools. Table 6 lists the events that were observed and the adult interviews conducted.

Table 6: Subject selection events observed and adult stakeholders interviewed

School type	Observations	Interviews
Government girls	Subject selection information night Subject information event	Deputy Principal Curriculum
Government co-educational		Head of Science Deputy Principal Curriculum Career Adviser
Non-government girls (2 schools)	Subject selection information night[1] Subject information event [1] Subject selection information night[2] Subject information event [2]	Deputy Principal Curriculum[1] Director of Senior School[1] Head of Science[1] Head of Science[2] Careers Adviser[2]
Non-government boys	Subject selection information night Careers expo	3 House Masters/Teachers Head of Science Science teacher Career Adviser
Open to all schools	Careers expo	
Totals	9 events	15 interviews

Notes.
[1]Non-Government girls' school 1
[2] Non-Government girls' school 2

A representative from each participating school assisted in providing information regarding subject selection events and information available within each school and identified adults within the schools who assisted students in their subject selection decisions. Details of findings relating to the Environment Phase are given in Chapter 5.

3.4.1 **Sample selection in the Environment Phase**

Subject selection events

The Researcher attended all subject selection events at four of the five participating schools. Subject selection events were not attended at the Government co-educational school as these events occurred prior to the school agreeing to participate in the study.

Adult interviews

Fifteen adults were interviewed within the five participating schools. These adults were chosen by the schools in response to a request for "1 Career Adviser, 2 Science Teachers, 1

Year co-ordinator plus others as recommended by the school" (Fresh Minds information to schools booklet see appendix B). The number of adults available for interview within each school varied. The Researcher interviewed three Careers Advisers, four Heads of Science, three Head of House/teachers, two Deputy Principals, one Science Teacher and one Director of Senior School.

3.4.2 **Data collection in the Environment Phase**

Subject selection events

At each subject selection event attended, the Researcher collected information documents and took field notes about the presentations on subject choice. These notes contained particulars of who spoke at the presentations, the subject matter of each presentation, and where science was mentioned and in what context. All materials given to students to assist in their decision making were collected. Table 6 lists the subject selection events attended.

Field notes from observations of subject selection events at different schools were compared to determine the type of information that was provided to students and the advice that students were given regarding subject choice. The references to Science that were made within presentations and the context within Science were mentioned were noted and compared.

Adult interviews

The Researcher interviewed all the adult stakeholders identified by school representatives as shown in Table 6. Interviews were conducted by the Researcher on the school grounds in a room allocated by the school. The duration of interviews was 20 to 40 minutes depending on the availability of the adult participants. Participants were assured of confidentiality of their responses and were briefly informed about the research. They were asked about their positions within the schools and the types of interactions they have with students in relation to subject choice. Participants were encouraged to speak freely and broadly.

The guiding questions for these interviews were:

- For Year 10, how clear do you think the students are about their subjects and the implication of subject choice?
- How do you think the information you provide helps students? Do you think they see it that way?
- Do students seek out help?
- What factors do you think students consider in their decisions?
- Do these students generally have a clear idea of what they want to do after school?
- How do they deal with the complexity of ATARs and assumed knowledge decisions?
- How fixed do they consider their choice of subjects (or career)?
- Why do you think students do or don't choose Science?
- Do you have examples of students who made decisions about Science you were surprised with?
- How would you get students more positively disposed toward choosing Science?

The interview concluded by asking interviewees: "Is there was anything I needed to know that has not been raised in the interview?"

All interviews were conducted, audio recorded and transcribed by the author.

3.4.3 **Analysis in the Environment Phase**

The documents and presentations provided to students were analysed to develop an understanding of the information environment within which subject choice was made. Content analysis was conducted on the written information provided to help students in their subject choice selection.

Data obtained through semi-structured interviews were also analysed thematically using the constant comparative approach. Open coding using this approach involved identification of concepts relating to the key themes revealed through the analysis of focus group data (Glaser & Strauss, 1967; Glaser, 1992). This analysis allowed comparison

between the factors that adults believed students considered when choosing subject and the factors the students stated they considered.

3.5 Survey Phase

The final stage of the Fresh Minds study was the Survey Phase. This involved the administration of a survey to students at the five participating schools.

Details of findings relating to the Survey Phase are outlined in Chapter 6.

3.5.1 Sample collection in the Survey Phase

The survey was made available to all students in Year 10 at the five participating schools. The survey was optional and the response rate varied greatly across schools. The survey was commenced by 379 students, with 333 of these students completing the BWS component.

3.5.2 Data selection in the Survey Phase

The survey consisted of multiple-choice, interval-scale, and free-response questions followed by a BWS component. The answers to these questions were designed to further investigate the difficulty and types of choices students made. The BWS surveys were designed to reveal the relative importance of the factors students considered as important in their decision-making process. The BWS component of the survey was presented in two versions: BWS-Accept and BWS-Reject. The BWS-Accept version was designed to gather data on the factors that students consider when accepting (choosing) a subject. The BWS-Reject version was designed to gather data on the factors that students consider when rejecting a subject. These two versions of the survey are presented in Appendix C.

Survey construction

The survey was created using a survey software package freely available through Qualtrics (https://qualtrics.com) and reviewed by supervising academics. It was tested with three students in Year 10 from one of the participating schools before being provided online for completion by student participants. These students did not complete the final survey. The

following section describes the process used to create, validate and administer the survey used in the Fresh Minds for Science study.

The survey opened with a brief introduction and students were required to give consent before entering the survey. Each respondent was presented with the same multiple-choice, interval-scale and free-response questions. Students were randomly allocated to either a BWS-Accept or BWS-Reject set of questions so that approximately half of the students provided data on factors for accepting (choosing) subjects and the remaining students provided data on factors for rejecting subjects.

Questions within the survey were forced response with the exception of free-response answers, which could be left blank. A forced response means respondents would receive an error message identifying the missing information and asked to complete this information before proceeding. Forced response was chosen because BWS analysis requires respondents to answer all sets of BWS questions. Classification questions (gender, class, school type, Science choice) and interval-scale questions were also set as forced-response questions to enable analysis of results from other questions to be analysed for specific groups of respondents. Respondents could choose to leave the survey at any time and come back to it at a later time.

Multiple-choice and free-response survey questions

Students completing the survey were presented with a number of demographic questions, with a drop-down menu of responses to choose from. These are indicated in Table 7.

Table 7: Survey demographic questions

Question	Response options
How old are you?	14, 15, 16, 17
What is your school year?	Year 10, Year 11
What is your gender?	Male, Female
What type of school do you go to?	Government girls school, Government co-educational school, Government boys school, Private co-educational school, Private girls school

Students were asked to answer the following free-response questions.

- If you have an idea what you will do after school please let me know what you have planned?
- If there is anything important that helped you choose your subjects that hasn't been mentioned in this survey, can you tell me about it here?
- Do you have some advice for me on how to encourage more students to study Science for Year 11?

These questions sought information regarding career intentions and gave respondents an opportunity to provide additional information they considered important. The survey concluded with questions regarding the respondent's choices with respect to the study of Science. These questions and response options are presented in Table 8.

Table 8: Survey choice of Science questions

Question	Response options
Did you choose to study Science for Year 11?	Yes, No
What Science subject(s) did you choose?	Biology, Chemistry, Physics, Senior Science, Earth and Environmental Science, Other (please write the subject(s) here)
Why did you choose a Science for Year 11?	Free-response
If you didn't choose a Science for Year 11 please tell me why?	Free-response

The questions on Science subject selection were placed at the end of the survey rather than at the beginning due to concerns that respondents may erroneously answer the BWS component of the survey in relation to their Science subject choice only.

Interval-scale survey questions

The survey used interval-scale questions to measure the level of agreement or disagreement with stimulus factors identified from the findings of the focus group study and the literature review. Interval-scales assume the scale elements chosen are equidistant thus allowing interpretation of differences between responses. Although there is debate as to whether intervals between choices in such scales are equal, this assumption is common in social sciences and therefore adopted in this study (Carifio & Perla, 2007). Interval-scales are simple for respondents to use and are common to both market research and social science research (Blalock et al., 2008; Brace, 2008; Proctor, 2005). These scales are also known to be particularly useful for online surveys where simplicity is important (Malhotra et al., 2012; Brace 2008).

Likert scales were considered for this study but were not used because as Carifio and Perla (2007, 2008) suggest, these scales are commonly misused and analysis of data from studies using them has led to questionable statistical inferences. Likert scales can be used within the theoretical framework of the TRA. However, this type of itemised rating scale is more suited to collecting attitudinal data. Further, Likert scales are slower for respondents to use than other itemised rating scales because each statement must be considered before selection of a response. Although these problems could have been overcome, the use of an interval-scale obviated this need and created a survey that was easy to administer.

In order to determine how difficult they found the subject selection decision making, students were asked to select an appropriate answer to the following questions using an interval-scale labelled: very difficult, difficult, neutral, easy, and very easy.

How difficult was it to...

- Choose the subjects you wanted to do?
- Choose subjects you did not want to do?
- Find out information about the subjects?
- Make your final subject selection?

Students were also asked: How sure are you about what you will study or choose as a career after you leave school? They were permitted to select between the five options of: no idea, a vague idea, some idea, pretty sure, and absolutely sure. Each response was presented as a 'radio button' that could be checked allowing only one option to be chosen. This question was designed to estimate a respondent's level of career indecision. The wording for these optional responses was based on the vernacular used by students in the focus groups to describe their degree of certainty in regard to their indecision/decision about subject choice.

Best Worst Scaling survey component

In order to determine the relative importance of the factors students consider in choosing or rejecting subject at school, BWS was used because this well-established technique allows factors to be ranked according to importance (Finn & Louviere, 1992; Marley & Louviere, 2005). The analysis of qualitative data resulted in a list of factors expressed as attribute statements that students consider in their deliberations regarding subject choice for their senior years at school. The list was compared with factors identified by other researchers (e.g., Lyons & Quinn, 2010) and refined into 21 factors of interest. The BWS ranking is achieved by asking respondents to choose their best and worst option from sets of factors. These sets present the factors multiple times in different combinations. Respondents do not need to state their attitude to each factor within the set but rather perform the less cognitively challenging task of choosing the option they like best and worst within the set presented. By comparing the choices respondents make within each set, a hierarchy of the mean relative importance of all factors can be created and quantified.

The focus groups had already revealed that students approached the subject selection decision from two viewpoints: accepting and rejecting subjects. This led to the development of two sets of 21 attribute statements, each approaching the BWS decision-making process from the opposite viewpoints, of factors for accepting a subject (BWS-Accept) and for rejecting a subject (BWS-Reject).

Each of the two sets of 21 attribute statements was arranged in sets using a balanced incomplete block design (Street & Burgess, 2007). This statistical design allows the

number of times a respondent sees each statement to be minimised while still allowing each statement to be assessed against all other statements. For the Fresh Minds survey, each statement set comprised five statements from which the students chose the statement they found most important (best) and least important (worst). Each statement was presented to the student five times resulting in 21 sets of five statements for each version of the survey (BWS-Accept and BWS-Reject). The attribute statements were randomised within each set to avoid question order bias.

For the BWS-Accept survey, the instructions to students read: "Please think about how you chose your subjects for Year 11. For each of the sets of features below, please select the feature that you find most important AND least important in *choosing* a subject to study." The BWS-Reject version replaced the word *choosing* with *rejecting*.

Examples of a set of statements presented to students from the surveys are presented in Figure 3.5 and Figure 3.6.

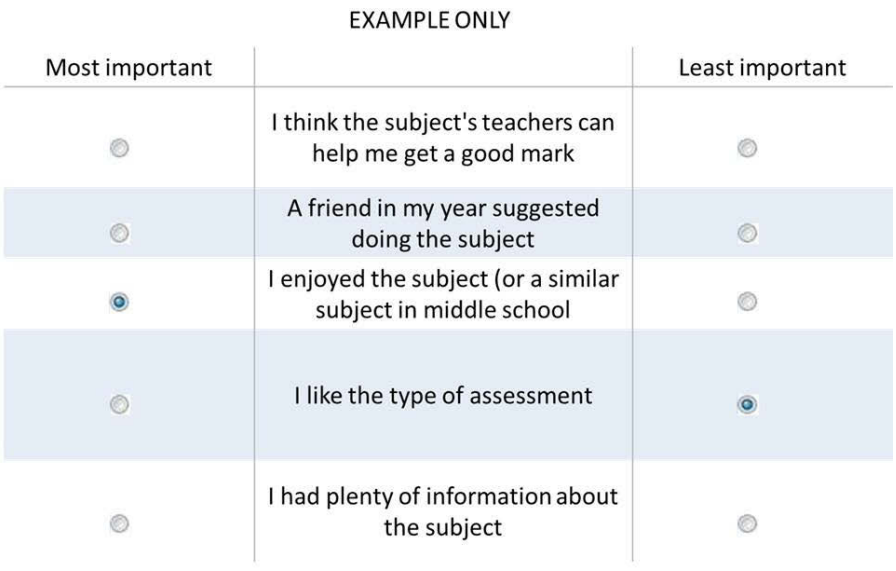

Figure 3.5: Example of BWS-Accept statement set.

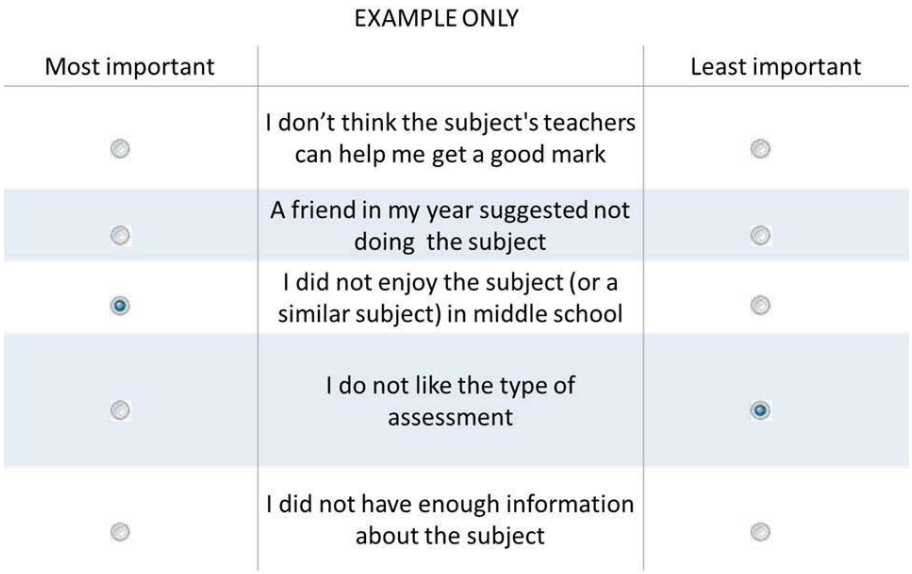

Figure 3.6: Example of BWS-Reject statement set.

The survey was arranged to assist students in tracking their progress through the survey in an effort to maximise the completion rate. This was accomplished by grouping the 21 sets of statements in the BWS component into sections creating five groups of five sets and a final group of six sets. This was aimed at presenting students with an apparently less challenging task of answering four questions of multiple parts rather than being presented with 21 questions. The survey also contained encouraging comments at the beginning of each BWS component. A limitation of BWS is that all questions must be answered and so it was particularly important that students completed all sections.

Survey validation

To validate the questions in the survey, three 16-year-olds in Year 10 from one of the participating schools were asked to explain their understanding of the meaning of each question. This was to check that the attribute statements forming the BWS survey were representative of the factors being investigated. These students did not complete the final

survey. The statements generated are shown in Appendix C and were worded in the vernacular of the Year 10 students participating in the focus groups. These statements were read aloud to the three Year 10 students and they were asked to explain what they thought each statement meant. Feedback from these students led to refinement of the wording of the statements until there was coherence between the intended meaning and the interpretation of the students. These three Year 10 students did not participate in the final survey. The survey was also reviewed by two research study supervisors, both of whom have expertise in the fields of education and choice studies.

The online survey was constructed and trailed by a further three students from a participating school who were statistically similar to the students in the school sample. These students completed the survey and provided feedback on their understanding of the survey and difficulty or ease of its completion. These students were asked if they found any questions confusing (non-sampling error). The students provided indicative timing for the survey, which they completed with a mean time of 15 minutes 21 seconds. They stated that they found the survey easy to understand and complete and did not suggest any changes. These three Year 10 students did not participate in the final survey and their survey responses from this trial were not used in the final analysis.

The survey was then submitted to the schools for review and no changes to it were suggested by school representatives. The survey was made active and available online to the Year 10 students at the participating schools via a password protected link.

Survey delivery

Schools chose different methods to administer the survey to their students. In the two non-government girls' schools, students were allocated class time to complete the survey and the Researcher supervised its administration. Students at the non-government boys' school were informed about the survey by their class Science teachers and invited to complete the survey in their own time. Students at the government girls' school were given a short presentation on the survey by the Researcher and invited to complete the survey in their own time. The government co-educational school emailed students an invitation to

complete the survey. Those students who were invited to complete the survey in their own time were sent email reminders by their school to complete the survey.

In all cases, students were informed that completing the survey was optional and that their views on choosing subjects were sought. This was reiterated in the introductory page of the online survey.

3.5.3 **Analysis in the Survey Phase**

Multiple-choice and free-response questions

Demographic data collected from multiple-choice questions were presented as totals and percentages. These responses were used to categorise data for analysis (for example, to analyse responses to interval-scale questions responses by gender).

The answers to the free-response questions were analysed by categorising responses according to the key themes resulting from analysis of the focus group data.

Interval-scale questions

The responses to the interval-scale questions in the survey were treated as interval-level data and analysed using parametric statistics. Descriptive statistical analyses were conducted and means (*M*), standard deviation (*SD*) and standard errors (*SE*) are shown. In order to analyse the differences between student responses to the interval-scale questions, inferential statistical analysis was conducted using Excel 2013 software. Pearson Product-Moment Correlation Coefficients (*r*), paired student *t*-tests (*t*) and *p* values (*p*) were calculated. The data was paired as students' data could be matched (that is, they had answered the same question). The null hypothesis for *t*-tests was that there was no correlation between answers by students to the interval-scale questions.

Best Worst Scaling

In the Fresh Minds survey, students were asked to choose the 'most important' and 'least important' statement which equate to the best and worst options (respectively). Survey data relating BWS scores and their relationship to the non-BWS portions of the survey were

analysed using the descriptive and inferential statistical functionality of Excel 2013 software.

BWS analysis (also called MaxDiff analysis) was used to determine a score of relative importance for each of the factors that impact the decision process being investigated (Marley & Louviere, 2005). MaxDiff assumes that when respondents are presented with a set of factors, they will evaluate all possible pairs of items within the set and choose the pair that reflects the maximum difference in importance. These pairs become the best and worst options chosen from the sets of factors presented. A score of importance for each item can be calculated for each item by calculating the frequency with which each factor was scored best or worst.

The score of importance for each factor in the BWS-Accept or BWS-Reject survey versions was calculated using Excel 2013 software. The analysis was the same for each version of the survey, thereby allowing comparison between the rankings of the 21 factors presented as 'Accept' or 'Reject' statements. For each factor, counts were made of how many times a respondent chose that factor as best and how many times the factor was chosen as worst. The number of times a factor was selected as worst was deducted from the number of times the factor was selected as best. Given respondents were offered each factor five times, if a student chose a factor as best on three occasions and worst on two occasions, the score would be 3 - 2 = 1. Therefore the value of the BWS score can range from a minimum of -5 in situations where a factor presented as a part of a set was always rated as worst up to a maximum of 5 where a factor was always rated as best.

The scores that result from BWS analysis may be compared, ranked, and interpreted as having ratio properties (Marley, Flynn, & Louviere, 2008). This means that a score of 2 for a factor means it is twice as important as factor with a score of 1 with respect to the decision-making process being investigated. These scores are calculated for individual respondents and are then averaged to produce a mean score of importance for the factor (the BWS score).

BWS scores were analysed using descriptive and inferential statistics. BWS scores were presented as means, standard deviation and standard error. Inferential statistics were

conducted using either paired *t*-tests when the data was for responses by the same individual or two samples (independent) *t*-tests to compare the BWS scores of different populations of students. The null hypothesis for paired data *t*-tests was that there was no difference between the scores for BWS factors. The null hypothesis for independent *t*-tests was that there was no difference between scores from the sample populations. The BWS scores for different populations was assumed to be normally distributed and this was verified using scatter plots. Variance was assumed to be unequal. The type of t-test used in each case is noted where tests of statistical significance have been conducted.

A minimum confidence level of 95% was chosen for this study, resulting in a minimum alpha level of .05 for all statistical tests. The levels of significance used in this study were:

- $p > .05$ weak or no presumption against the null hypothesis
- $p < .05$ strong presumption against null hypothesis (denoted *)
- $p < .01$ very strong presumption against null hypothesis (denoted **)
- $p < .001$ extremely strong presumption against null hypothesis (denoted ***)

3.6 Risks and limitations of the study

This section outlines the risks and limitations of the Fresh Minds study.

3.6.1 **Procedural risks and ethical considerations**

Ethics approval was granted for this study by the University of Technology Sydney's Human Research Ethics Committee (Approval number: UTS HREC 2012-392). In order that research be conducted in government schools, approval was obtained from the NSW Government through the State Education Research Approval Process (SERAP approval number: 2012296). Participation in the study required written consent from the school principals and adult participants. Student participants in the focus groups required personal consent and consent from a parent or guardian. Survey participants were required to provide online consent before being permitted to complete the survey. All consent forms, fact sheets, and the survey instrument used in the Fresh Minds study were approved by the University of Technology Sydney's Human Research Ethics Committee. Participation in

Fresh Minds was voluntary and participants could withdraw at any time without explanation. Participants received no extrinsic rewards for their contribution but students were provided with snacks during the focus groups. The risks associated with Fresh Minds for Science and how these were addressed are outlined Table 9.

Table 9: The risks identified and managed within the Fresh Minds study

Risks identified	Risk mitigation
<u>Focus group risks</u>	
Students may find the process of sharing information about what they feel uncomfortable given other participants were sitting in the same room. Students may feel uneasy with an adult guiding the discussion and viewing its progress.	This risk was found to be negligible. The information sought about subject choice was not seen to be sensitive by participants.
Focus groups have been criticised for the following shortcomings: Participants can over-rationalise their behaviour and misrepresent their true motivations. Emotional behaviours are not displayed. Participants may make up answers. Poorly run groups give poor data. Dominant people can dominate the group. (Krueger & Casey, 2009)	Risks were low to moderate. Teenagers appeared to enjoy giving their opinions and gave them openly. The focus groups were moderated effectively.
<u>Survey risks</u>	
Survey participants may have felt obliged to participate rather than volunteering because they have been told to by their teachers. This may cause them distress if teachers do not make it clear that the survey is optional and that participation would not affect their grades.	Negligible risk found. The information sought about subject choice was not found to be sensitive to participants. Students were instructed the survey was optional and anonymous.
Students may not know why they choose what they do. Schools may not be representative. Limitations of focus groups and surveys. Technical problems with survey. Low response rate for survey. Issue of getting data at the best time. Ethics of producing results that are inappropriately used.	Risks in this area were found to be low. Response rates were good and data collected at the appropriate time. Care was taken in feedback of results to schools.
<u>Adult interview risks</u>	
Adult interviewees may feel uncomfortable about sharing their opinions.	Negligible risk found. The information sought about subject choice was not found to be sensitive to participants and adults gave their opinions openly.

3.6.2 **Data protection**

Data collected from students were anonymous and school names were replaced by codes. Any identifying information that students added in free-field areas of surveys was permanently deleted. All sensitive files relating to this study are securely maintained in a password protected environment.

3.6.3 **Limitations of the methodology**

There are limitations to the methodology adopted in this study. In addition to the risks discussed in 3.6.1, the restricted sample size is the major limitation of the study. Due to constraints of working in a school environment, the study used a purposive convenience sample. Schools endeavoured to provide participants for focus groups as requested. However, representatives stated that the difficulty of finding times for students to be available with the result that focus groups varied in size and composition. Notwithstanding this limitation and the fact that some groups were small, there was a spread of students across genders and school sectors.

The external reliability of inferences made from the analysis of focus groups in the qualitative component of the study is limited by the convenience sample utilised. The participating schools were from a small geographical area representing students of high socio-economic status. Non-government schools provided more participants and so were over-represented. Further, although the male to female ratio was almost equal in the study, the majority of the male sample came from a single school. The consistency of views provided by students suggests these views are indicative of student opinions and behaviour generally in the area of subject selection. The results from this sampling cannot be viewed as representative of the Year 10 students generally but may have some transferability to students with similar socio-cultural characteristics to those sampled.

Quantitative results from the survey were similarly limited by the restricted sample size. A sample size of 383 was required for statistical validity at the 95% confidence level for the results generalised to the population of Year 10 students. The number of respondents for the BWS component of the survey was 333 meaning these results cannot be confidently generalised. The composition of the sample also limits generalisability because,

as mentioned above, the schools sampled were not representative of schools in NSW. In addition, differing numbers of students from participating schools completed the survey. Thus generalisations based on the empirical data from the survey are limited. Although results may not be generalised to a wider population of students, they may be indicative of a subset of similar schools.

A final limitation is that the results of the BWS survey cannot be validated because no similar BWS studies have been conducted with school students.

3.7 Summary

This section outlined the methodology used in the Fresh Minds study to investigate student subject choice. The methodology chosen has a marketing focus that is supported by the strong theoretical basis provided by the behavioural model of the TRA. The exploratory sequential design for this study was carried out in a rigorous manner to enable valid and valuable qualitative and quantitative data to be gathered. The findings of the Fresh Minds study allow for the development of a model for the decision making students' use when choosing subjects and how that process impacts the choice of Science at school. This new knowledge is used in the conclusion chapter to suggest marketing-informed strategies to increase the numbers of students choosing to study Science in the final years of school.

The next three chapters describe the data collected and analyses completed in each phase of the Fresh mind study.

CHAPTER 4: **Focus Group Phase**

4.1 Introduction

This chapter describes the findings of the Focus Group Phase of the Fresh Minds study. The information discussed here was obtained through 15 focus groups conducted with 50 students in Years 10 and 11 at four schools. This phase addresses the two discovery-oriented research questions:

- What decision-making process do students use to decide which subjects to study for Years 11 and 12 at school?
- What factors do students consider when choosing their subjects for Years 11 and 12 at school?

The analysis conducted in this phase of the study revealed that there were three main themes related to student choice of subject: student characteristics, subject characteristics, and choice process. Each of these themes contained a set of factors that impacted on students' deliberations regarding subject choice. The factors were found to be interrelated both within themes and between themes. All coding was conducted by the Researcher and the nodes were created based on the subjective interpretation of that researcher to the responses of students. In addition to developing an understanding of the subject choice process, the purpose of the focus group phase was to identify factors for choice for the BWS study conducted in the Survey Phase. The detailed level of analysis conducted in this phase was required to produce an exhaustive list of factors that may be influential in the choice of Science.

The Focus Group Phase revealed that subject selection decision-making was generally seen by students as important and difficult. Analysis of student descriptions of the subject selection process revealed that this decision was in two stages with different selection criteria being employed at each stage. Overall, students stated that they chose the subjects that they believed that they would enjoy and would find useful for future study or a prospective career.

This chapter comprises four sections. Section 4.2 provides a description of the method of analysis of the focus group transcripts and how this analysis resulted in the development of nodes containing key themes relating to student subject choice. The relationship between nodes is discussed. This is followed by an analysis of the focus group findings in section 4.3 within each of the three parent nodes - Student Characteristics, Subject Characteristics, and Choice Process. Section 4.4 presents findings related to the Fresh Minds discovery-oriented research questions.

4.2 Analysis of the focus groups

4.2.1 **Overview**

Focus groups were held with groups of students from Years 10 and 11 from four participating schools. Fifty students were involved in 10 focus groups; there were six Year 10 groups comprising four to six participants and four Year 11 focus groups comprising from two to six participants. The participating students were from government and non-government schools. Most focus group students attended single-sex schools, with one mixed-gender Year 10 focus group comprising two boys and three girls from a co-educational government school.

The sample size was based on two focus groups from each of Years 10 and 11 at each school in order to allow comparison between these years. As there were no notable differences between the views expressed by students in Years 10 and 11 comments from the two Year groups have been combined in this analysis. Comments made from successive focus groups were also sufficiently similar to give confidence in the information gained that the sample provided by the schools is representative of the target population of students at those schools.

Students participating in the focus groups were asked about the ways in which they chose their subjects generally and also specifically about their subject choices with respect to Science. Details of the questions guiding the participation are presented in section 3.3.2.

4.2.2 **Nodes**

The focus group transcripts were analysed to identify themes and these were coded as 'nodes' using the software package NVIVO (version 9.2). As the information was reviewed, additional nodes were added and comments relating to those nodes was placed within the relevant node. The process of coding was iterative; as new themes were discovered, those transcripts already coded were reviewed and recoded if necessary. Comments were coded to multiple nodes if they related to multiple themes. Relationships between nodes were discovered through the analysis of instances where comments were coded to multiple nodes. The coding resulted in the creation of three groups of interrelated nodes: Student Characteristics, Subject Characteristics, and Choice Process. To identify nodes when referred to in this thesis, these have been capitalised.

Node structure

The Student Characteristics, Subject Characteristics, and Choice Process parent nodes contained comments which related to particular themes represented by the nodes. Each of the three parent nodes contained associated child nodes that contained specific comments on factors relating to the general theme represented by the parent node. Comments from students relating to a theme represented by a child node were coded to that node. Student comments were often coded at more than one node indicating that the nodes were interrelated. For example, students who stated that they chose a subject because a teacher they had in middle school made the subject easy to understand, would have this comment coded into both the Teaching node within Student Characteristics and Difficulty within Subject Characteristics. Relationships, as evidenced by common coding, were found within and between the three parent nodes. To identify child nodes when referred to in this thesis, the first word of the child node is capitalised. These relationships are discussed later in this section.

The Student Characteristics parent node has four child nodes: Interest and enjoyment, Ability, Gender, and Teaching. Further, the Teaching child node was found to contain a subset of factors: Quality, Previous experience (of teaching), and Attitude to teacher.

The Subject Characteristics parent node has four child nodes: Logistics, Difficulty, Usefulness, and Career. The Career node could be further described by a subset of five factors: Knowledge of career; Australian Tertiary Admission rank (ATAR, used for university entrance) and scaling (used as part of the ATAR calculation); Career information; Career advice; and Career or study need.

The Choice Process parent node had six child nodes: Choice of subject method, Subject information, Parental influence, Peer or sibling influence, Complexity of choice, and Teacher advice.

Figure 4.1 displays the structure of the parent and child nodes and the relationships resulting from analysis of the focus group transcripts. The intersection between parent nodes in this diagram illustrates that comments from students could be coded to multiple nodes, indicating nodes may be interrelated.

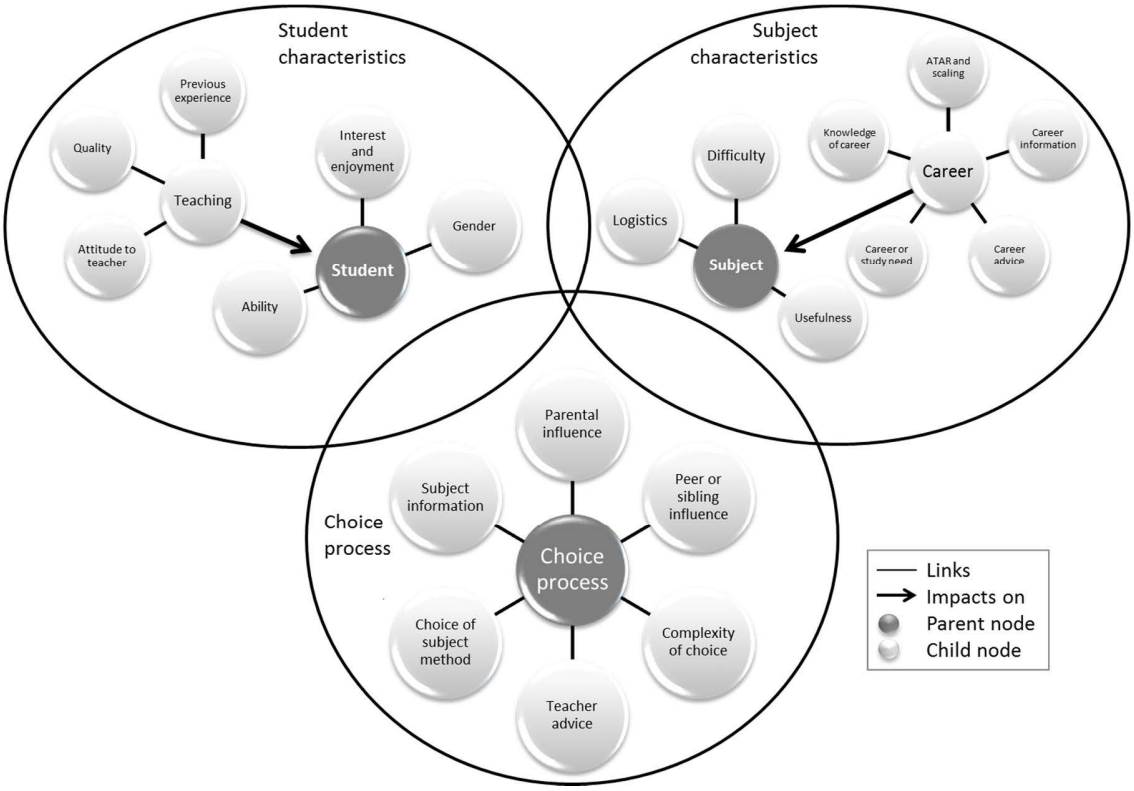

Figure 4.1: Coding relationships of focus group parent and child nodes.

Each node contains participant statements that relate to that particular node. The focus group transcripts did not identify individual students and so multiple references may come from the same student. However, a string of statements from a student on a topic would be coded as a single coding reference. If a comment string pertained to several nodes it would be coded to each of the nodes to which it is related. Figure 4.2 shows the number of coding references made in each child node and parent node. This figure provides an indication of how often particular topics were referred to in discussions. When considering Figure 4.2, it is important to take into consideration that students can make multiple comments on the same topic and each discrete comment would be presented as a unique coding reference.

Figure 4.2 shows that the nodes containing the most comments are Interest and enjoyment, and Ability, each of which contains over 50 statements made by students. The

nodes with the fewest comments coded to them are Career information and Gender. The node Gender contained a single coding reference for this quote (see section 4.3.1).

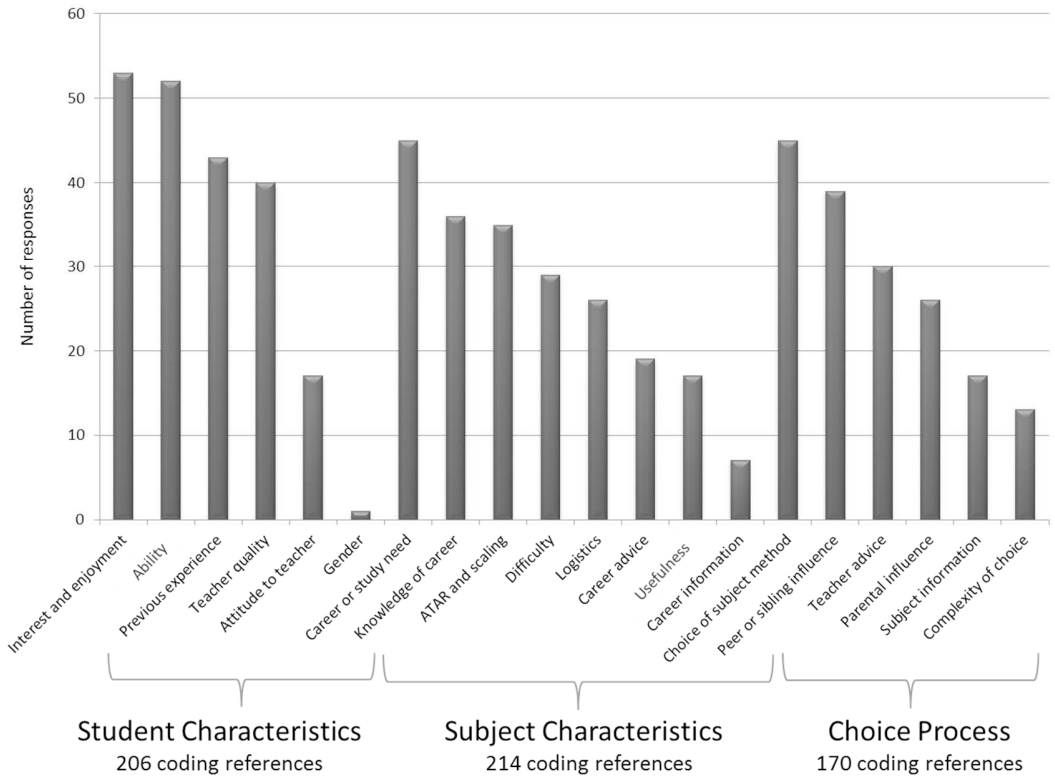

Figure 4.2: The number of coding references for child nodes grouped into parent nodes.

Relationship between nodes

The interrelatedness of student comments was analysed by measuring the degree of common coding between nodes using Jaccard's coefficient (Jaccard, 1912; Tan, Steinbach, & Kumar, 2006). This statistical coefficient compares the similarity and diversity of sample sets by looking at the ratio of the common content to the content that is different (intersection of sample sets divided by the union of the sample sets). Figure 4.3 shows a dendrogram where nodes that have similar coding (as measured by Jaccard's coefficient)

are clustered together on branches of the diagram. The further apart that nodes are located on the branches of the dendrogram, the less similarity there is in coding of statements within those nodes. Figure 4.3 shows that several sets of comments were commonly coded together. Indeed, the Jaccard's coefficient for three pairs of nodes was 1, which meant almost all comments made in these nodes were coded to both nodes. These three pairs of nodes were the Jaccard's coefficient was 1 were: Interest and enjoyment with Ability; Peer or sibling influence with ATAR and scaling; and Usefulness with Previous experience (of teaching). This means that students nearly always spoke on these topics together, suggesting that they are closely linked. This is discussed further in the description of each node cluster. The comment concerning gender was not related to any other comments made by students about subject choice.

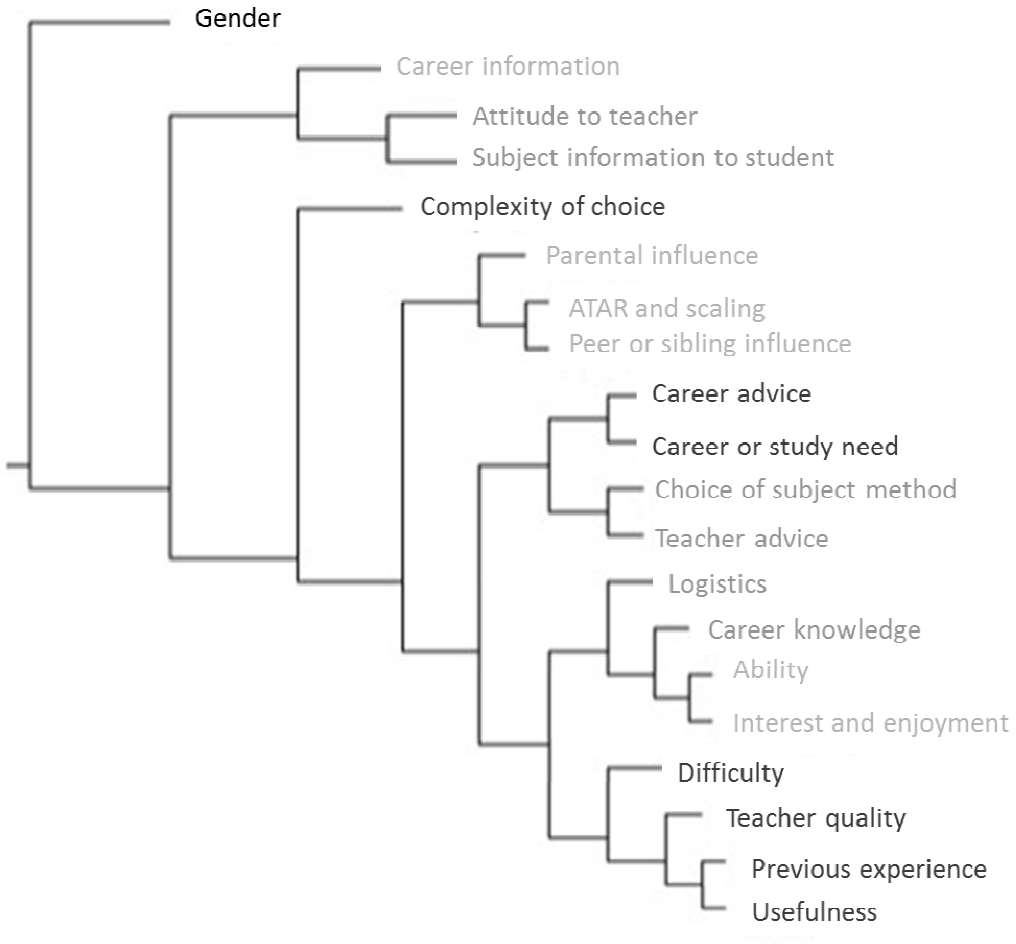

Figure 4.3: Dendrogram showing nodes clustered by coding similarity.

This section has described how the structure of parent and child nodes in which recurrent themes in the focus group discussions were coded. Analysis showed that the three parent nodes of student characterists, Subject Characteristics and Choice Process were interrelated. The next sections discuss key findings in each of these parent nodes.

4.3 Focus group findings

4.3.1 **Student characteristics**

The Student Characteristics parent node comprises student comments relating to a student's personal preferences and ability to do well in subjects and how these comments relate to the subject choices students make. Figure 4.4 shows the structure of the Student Characteristics node showing the parent node (labelled 'Student') and the child nodes associated with that parent node. As noted earlier, comments relating to Student Characteristics were coded in four child nodes: Interest and enjoyment, Ability, Teaching, and Gender. Teaching was further analysed and found to be comprised of three factors: Previous experience (of teaching), Quality (perceived by student), and Attitude to teacher. Figure 4.4 shows the structure of the Student Characteristics node. Key factors relating to students that impact on subject choice will now be discussed.

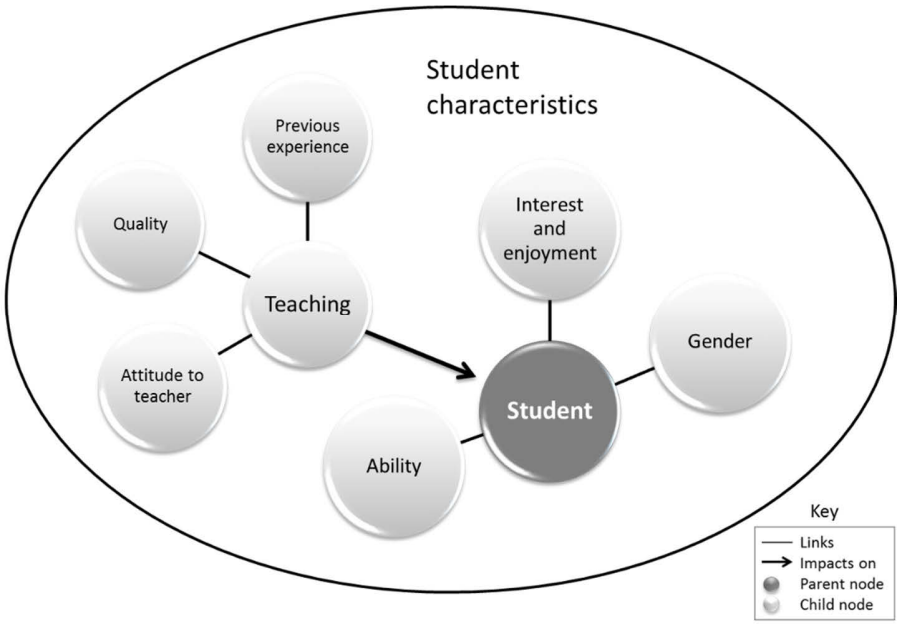

Figure 4.4: Student characteristics nodes.

Interest and enjoyment

Students widely stated that the primary reason they chose a subject was an interest in or engagement with that subject. Although interest and enjoyment are not synonymous, as enjoyment can be the result of many factors including interest (Krapp & Prenzel, 2011), the terms 'enjoy', 'like' and 'interest' were used interchangeably by students to convey the idea that they generally had positive feelings towards a subject. When asked why they chose certain subjects, students commented that they generally chose subjects that they enjoyed and avoided subjects that they did not enjoy. There were 20 student comments about avoiding subjects they did not like and 10 about subjects they enjoyed. This may indicate that students are more focused on avoiding subjects that they do not like than choosing subjects that they do like. Subject acceptance and avoidance is discussed further in the Choice Process node discussion (Section 4.3.3).

Ability

Students commented on the relationship between academic proficiency in a subject (being 'good at' a subject or 'getting good marks') and their interest and enjoyment of a subject. Comments coded within the node of 'ability' were almost always also coded to the node of 'interest and enjoyment' which suggests that these two themes are closely linked. Several comments (n = 8) were made about the links between ability (for example, the ability to get good marks) and enjoyment or liking a subject. Students commented they found subjects that they enjoyed required less effort to produce good marks. For example this student stating that if he enjoyed a subject:

> I find that I don't have to put too much effort into it to get a good mark. (Year 10 boy)

Students also commented that choosing subjects that they enjoyed was the best strategy for choosing subjects. This is exemplified by this quote:

> I think it was about what I liked. I think because in the future I will do something I like. (Year 10 girl).

One student indicated that if she did poorly at a subject she did not enjoy it as follows:

> If I'm not good at it or if I'm not enjoying it then I will hate it. It just doesn't run with me. (Year 11 girl)

Three students stated that they would choose a subject they did not enjoy if they felt they needed it for a future career or could obtain good marks in it. The following comment explains the rationale for this position:

> Then you think, I am good at this and I'll get good marks, so I should continue, even though you are not having fun or enjoying it. (Year 10 boy)

However, students specifically reported on 20 occasions that they would not do subjects that they did not enjoy. Two typical comments expressing this view are:

> I do well at Science but I don't like it so, for me, I was choosing the subjects that I enjoy doing. (Year 10 girl)

> I was never bad at Science but I didn't really enjoy it. I have more of a Maths brain than a Science brain so I was finding in Chemistry and Physics I really had to try hard, not that I didn't like trying hard, it is just that in comparison to the ease of the other subject, when it came down to choosing, I prefer to do something that I enjoy and find a bit simpler than having to work really hard. (Year 11 girl)

As indicated by the previous quotes, students spoke in terms that suggested they considered abilities for certain subjects to be innate.

Students who performed well in a range of subjects appeared to place more importance on selecting subjects that they found interesting. When student who was good at Science was asked why she chose not to take any Science, she stated that:

> I just wasn't finding it as interesting as my other subjects. (Year 11 girl)

Students with fewer interests or lower overall history of achievement found the subject choice decision to be one of choosing between unattractive options. For example, this student stated:

> I had to find units when I was choosing my subjects because I was not that good at a lot of subjects. (Year 11 boy)

The relationship between academic proficiency, enjoyment and motivation was described by the following student:

> I think that there has to be a balance between what you are good at and what you love because if you choose everything that you love, you might not necessarily be doing very well and it might bring your marks down, but if you choose things that you are doing really well in, but you might not necessarily love them, you are not going to have the motivation to keep doing well. (Year 10 girl)

Gender

Within Student Characteristics, gender was raised as an issue for choice of Science on one occasion. This student stated:

> I think it seems very daunting because it is often a male subject bluntly you often hear about guys doing really well in Sciences and not so much about women. (Year 11 girl)

Both genders described the subject choice process in a similar way. However, the boys in these focus groups displayed less concern than girls about the importance of choosing HSC subjects. Boys also did not report discussing their deliberations extensively with their friends, as was reported by most female participants.

Teaching

The comments that were coded to the teaching node within the Student Characteristics cluster were found to relate to three interrelated areas: Teacher experience, Quality (of teaching), and Attitude to teacher.

Teacher experience. Perceptions of previous teaching experience in a subject were frequently spoken of by students with regard to subject choice. These comments about teaching were more often negative than positive. Students commented on 23 occasions that unengaging teaching influenced their view of a subject. Here are three examples:

> On teachers, because I was just thinking why I really didn't do Science. I honestly think that I really only had one really inspiring Science Teacher through my years and that was at the end. (Year 11 boy)

> I suppose it depends on the teacher. Like in the first two years I had this teacher and she was like very boring. She was quite old. (Year 10 girl)

> With science I never had a particular teacher which I enjoyed through my entire year 7 to 10 and I think that would've affected how much I like the subject. (Year 11 girl)

Countering this view were the comments of two students who stated that dislike of a teacher or their anticipation of poor teaching was not sufficient to dissuade them from choosing a subject.

Four students specifically mentioned a good experience with past teaching had a positive effect on their view of Science. The following quote exemplifies this view:

> For Year 8 I had a really great Science teacher. I loved Science. (Year 10 girl)

Quality. Three students specificially related their own academic performance to their perception of the quality of the teaching they received. One commented:

> It really depends on the teacher I reckon. Like in a lot of subjects I had done well in, it was because of my teacher. (Year 10 girl)

In addition to providing an engaging environment so that students could 'like' a subject, one student commented that he relied upon teachers' practical support to learn a subject as follows:

> You can't really be responsible for your own learning. It doesn't work most of the time. (Year 11 boy)

One student suggested the alternate view, that learning was a student's responsibilty rather than their teachers'.

Students did not know which teachers they would be allocated for Year 11, and so a student's ability to estimate future teaching quality for a subject was limited. If the faculty is small, students could infer which teacher they may have in Year 11, and the risk of getting a teacher they believe to be poor can be sufficient for some students to consider not choosing a subject. One participant said, with respect to the risk of getting a teacher they perceived to be poor:

> If you know you were going to get the teacher, you don't want to really do that subject. (Year 10 boy)

To assess the quality of expected teaching for a subject, students looked to the performance of their past teachers and evidence of the efficiency and effectiveness of a faculty. This is exemplified in the following quotes:

> We never really do hear about it in our end of year assemblies - all of these kids who had like topped in Science could be counted to the teaching as one factor. (Year 11 boy)

> In Science, I waited four weeks before I got it [an assessment] back. Doesn't make you confident. (Year 11 boy)

If students had reservations about certain teachers for a subject area then they were discouraged from taking a subject in that area. It appeared that students were assessing not only the teachers of individual subjects but the performance of the faculty in general.

Attitude to teacher. Six students indicated that their attiude to a teacher impacted on their perception of a subject. Two of these stated:

> Teachers can put you off subjects. (Year 10 boy)

> If you don't like a teacher, you won't really enjoy the class. (Year 10 boy)

Students expressed that they found it easier to obtain better marks in subjects they enjoyed and that this was influenced by their past experiences of teaching. Students more frequently made negative comments about past teaching (n = 23) than positive comments (n = 5) and noted that teaching was a consideration in subject choice decision making. Upon asking students about their Science subject choice specifically, students made 19 negative comments regarding their Science teaching experiences compared with three positive comments. These findings suggest that students' attitudes towards teachers may be more influenced by past negative teaching experiences than by positive teaching experiences. Given that students reported a link between the teachings they received, the marks they obtained, and their enjoyment of a subject, their perception of the quality of teaching in a subject may be an important consideration in subject choice.

The next section discusses the node cluster of Subject Characteristics.

4.3.2 **Subject characteristics**

The second theme contains student perceptions regarding the characteristics of subjects and how these influence a student's subject selection. Figure 4.5 shows the child nodes influencing the parent node of Subject Characteristics (labelled 'Subject') as Difficulty, Usefulness of the subject, Logistics of choice, and Career. The Career node was expanded to cover a set of nodes related to career and future study consideration; Knowledge of career, ATAR and scaling (related to university entrance), Career information, Career advice, and Career or study need.

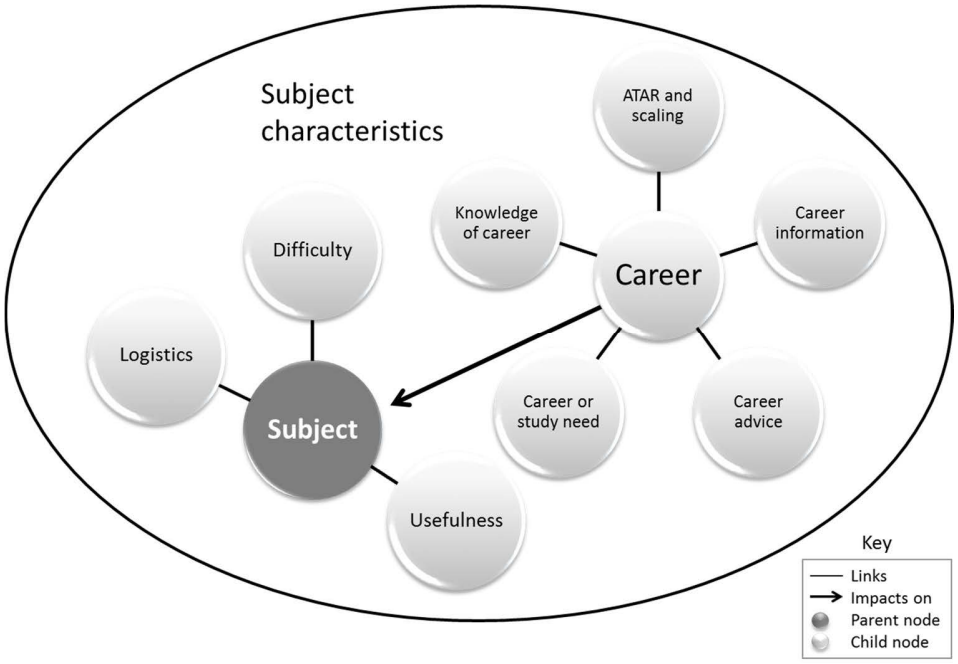

Figure 4.5: Subject characteristics nodes.

Subject attributes

Logistics. The logistics of the subject relates to the availability of subjects and their assessment. Schools set a maximum number of units that students may take and construct timetables based on the subject choices of students. Timetabling was not cited as a problem except for one student who wanted to do more than the number of units allowed by the school. He said:

> I kind of wanted to do 13 units but I couldn't because the school is a bit weird. It was just the timetabling. (Year 10 boy)

Some students stated that they either chose to take, or were required by their school to take, subject units which were additional to those required by the rules of the HSC (see Appendix A for a summary of these rules). Three students stated that they were taking subjects in Year 11 that they intended to discontinue in Year 12. Students discontinue subjects in Year 12 to either reduce their number of units and/or so that they can take up extension units in other subjects. Science subjects were not considered as suitable for these extra subjects for study in Year 11 because of their difficulty relative to other subjects. This is exemplified in the following comment:

> Initially I had Physics instead of business studies but then I thought, hey, Physics is going to be way too hard for just one year. So if it's not going to help me then I'm just going to say nuh. (Year 11 boy)

Students commented on five occasions that the format of assessment of a subject was a consideration in subject selection. Three of these comments were statements about avoiding 'major works' that are substantial compositions to be produced as part of a subject's assessment. For example:

> I purposely chose subjects without a major work. (Year 11 girl)

A fourth student commented that she avoided subjects requiring essays. A fifth student gave the opposing view and said he had:

> Changed to essay subjects which were better for me. (Year 11 boy).

Science assessment in NSW does not require production of a major work and normally does not require the completion of essays. One student stated that she believed some students may have been discouraged from taking Science at their school because there was an essay in the Science examination the students completed just prior to choosing their subjects. She expressed the view that:

> I think if you asked, everybody didn't enjoy the essays. (Year 11 girl)

Difficulty. When selecting a subject students consider the perception of its difficulty. Each student perceives this difficulty differently according to their academic proficiency (ability) in individual subjects. Ability is discussed as a component of Student Characteristics in section 4.3.1.

Students assessed subjects to determine how demanding they were likely to be for future study. Students' definitions of what is more or less demanding varied but the 29 comments made on the issue were linked to views of the amount and type of content, and the way the subject is assessed. Students commented specifically on Science in this regard and there was wide variability in the way Science was perceived. Some students perceived Science as a subject that was focused on students' acquiring and remembering factual information, whereas other students saw Science as being a subject directed at understanding and explaining phenomena. Typical comments on these differing views are offered by these four students:

> One thing I have about Science is that Maths was very easy because when you had a question in Science… in Science it always kept coming up why, why, why and in Science they don't explain it to you because it just is…It is just the way it is whatever. (Year 11 boy)

> Just for me there was a lot of content [in Science] and I was like, it was just too much for me right now. (Year 10 girl)

> Why I struggle in Physics a lot is that it is intangible, you can't see it and you have to imagine it and that makes it even harder. (Year 10 girl)

> It is easy to get a high mark in Maths and Science because there is a right answer and a wrong answer. (Year 10 boy)

Students reported more often (16 against 7) that Science is harder than other subjects with one student remarking that Science is only difficult for "the parts that don't make sense." (Year 10 boy).

The perceived difficulty of Science subjects may be indicative of a student's inability to understand the concepts presented, the curriculum, or issues with the way concepts have been taught. Students who saw Science as a more demanding subject commented that Science subjects were hard because they had large amounts of content to be remembered and thus the student required a good memory, for example:

> People who are good with memories, that is their strong point, then maybe Science would be their thing because there is a lot of memorising. (Year 10 girl)

Countering the general view that Science is more challenging than other subjects were some students who stated that Science was simpler to understand and study than other subjects. Five of these students specifically commented that Science was less challenging than other subjects because it was factual and they found this style of subject preferable. A student defined Science by saying:

> It's a more narrow way of thinking and if you study for like one part of the syllabus it is usually the sort of things you are going to get. It's not as broad … if you know your stuff it will get you the marks. (Year 11 boy)

In addition, as discussed in section 4.3.1, the students' views on past teaching of subjects and their expectations of future teaching impacted on their notion of whether they would find a subject difficult.

Usefulness. Students associated the usefulness of a subject in terms of preparation for a future study path or career. Those students who were unsure of their future career path and had not developed a dislike of a subject may consider keeping the subject in order to maintain a broad range of subjects.

Students were asked about the general usefulness of Science other than as a requirement for a scientific career. The link students made between enjoyment of a subject and a career involving that subject appeared to be particularly relevant with respect to

Science. Students repeatedly commented that Science is a subject needed for stereotypical science careers such as engineering, medicine or becoming a scientist but found it difficult to identify any general use for the subject. Two students stated that the Science subjects were useful only if you were planning to specialise in stereotypical scientific areas:

> People who don't want to be a scientist… Science is not really necessary to them. I don't have to choose it, I will choose something else. (Year 10 boy)

> Some people find it interesting but a lot of people know they want to do something to do with science and so they feel they have to take it. (Year 10 girl)

Two students acknowledged that Science could be viewed more broadly:

> It really gives you an understanding of life. (Year 10 boy)

> You need to bring out what Science actually is and not just one little corridor. (Year 10 boy)

This finding is consistent with Lyons and Quinn's (2010) study, which showed an important factor in students not choosing Science was students' difficulty in seeing themselves as scientists (Lyons & Quinn, 2010).

When students in one focus group were specifically questioned about whether science was generally useful in life outside of a career, they looked confused. One tried to explain the confusion by stating:

> If you look at things happening, you don't think 'that is the formula for photosynthesis'. (Year 10 girl)

The students in this focus group were unable to identify a use for science in their personal lives.

In a different focus group, a student acknowledged that there had been attempts to broaden students' views of Science but that he remained unconvinced in stating the following with respect to Science:

> It's becoming more and more useful - that's just what we're told by people who come in. (Year 11 boy)

When asked if the students agreed that Science is as useful as other subjects, *all* students in this focus group disagreed.

Students commented on nine occasions that Mathematics was a subject that was necessary after school and two students stated that they would do Mathematics despite not enjoying it. One student said:

> I can't wait to get rid of Science and I don't really like Maths but I am doing it anyway. (Year 10 girl)

Similar remarks were not made about any other subject. Indeed, one student stated:

> As an employer, I would not employ somebody without Maths. (Year 10 boy)

Career factors

Career considerations impact on subject choice and were categorised as a child node relating to Subject Characteristics. This coding was chosen as students indicated they made judgments on how useful a subject will be in their future and mainly considered this in terms of a future career or study path. As shown in Figure 4.5 comments coded to the Career child node were further coded into five nodes: Knowledge of career, ATAR and scaling, Career information, Career advice, and Career or study need. This section presents findings relating to these nodes.

Knowledge of career. Of the 50 students participating in the focus groups, three stated that they had a clear idea of their intended career path and another three stated that they had no notion of what career they wanted to pursue after school. The remaining students were unsure of their future education, career path, or were unwilling to commit to a career field. One focus group of Year 10 girls, when asked if they thought they were too young to be thinking about careers, enthusiastically and unanimously responded that they thought they were.

ATAR and scaling. Students were provided with information on university courses by their school. One focus group of Year 10 boys were presented with university entrance materials that were yet to be provided by the school. All the students in this focus group immediately

looked at the ATAR required for admission to specific university courses. This suggests that these students had some idea of the courses they were interested in.

Students often spoke about ATARs and the scaling of subjects that play a role in calculating a student's ATAR (see Appendix A for a description of calculation of the ATAR and scaling). Students commented that they had received advice from teachers not to choose subjects based on subject scaling. However, in the focus groups students discussed ATARs and scaling at length. They expressed conflicting views as to their importance and how the scaling system led to the calculation of an ATAR. Four students stated they chose to ignore the topic of university entrance but the majority of students stated that they thought about ATARs, particularly those who were looking to do courses that require a high entrance rank. One student commented on the importance of a high ATAR as follows:

> If you aim for something very high you can't ignore the ATAR 'cause nothing I want to do is below 98. (Year 10 girl)

Students were confused about prerequisites and assumed knowledge requirements for university entrance. One student specifically commented as follows that Science is not a prerequisite for many science-based university courses although Mathematics is:

> I think that is the difference between Science and Maths, because I know that for a lot of courses, Maths is a prerequisite. It is an assumed knowledge whereas Science isn't for Science specific subjects. (Year 11 boy)

Career information. Students received general information about the range of careers available, for example:

> We have had career seminars to see what subjects we want to take for the jobs we may have in the future. They are pretty broad, they are not specific, so you don't get much information about what you want to do. (Year 10 boy)

One student said he had been to a career fair at the school and found it interesting but commented:

> I really didn't think that Year 10 was the year to focus on universities because you have got another two years after that to actually go out and have a look and see and know what electives you are doing for next year units and all that and see what is the best university then. (Year 10 boy)

This comment is consistent with the focus group of girls who enthusiastically agreed that they were too young to be choosing careers.

Students could find career information unhelpful if they were undecided on their career choice, for example, one student commented:

> I think that if you have no idea its kind a bit of an overload. (Year 11 girl)

Students in the non-government schools had careers profiling and were mixed in their interpretation of the usefulness of this profiling. Most commonly, the profiling and career advice information were seen as confusing because it provided a large range of options and recommended careers that the students did not think were suitable for them, as stated by these two students:

> Yeah. We did [have career profiling] but it wasn't helpful. It just gave us a massive list of careers which we could do and it didn't narrow it down. There was a Bicycle Technician and we thought, well that's great! (Year 10 girl)

> I got told I should be a primary school teacher and I hate children! (Laughing) I am the most impatient like bad teacher so it's like no it's just so wrong so I said like I really want to do psychology or law and she [the profiler consultant] said oh. (Year 10 girl)

Career advice. Four students chose to individually discuss specific career options with the school Careers Adviser. One of these stated that they were verifying subjects for a chosen career path in engineering, two were undecided but said they found it beneficial and one student stated that she found the differing the views offered by the Careers Adviser and teachers within her school confusing. She stated:

> I researched, I went to my Careers Advisor so many times and I asked for help from other teachers but within this school, even the teachers had different ideas and that is what confused me the most. (Year 10 girl)

Career or study need. Students stated that in choosing subjects they considered their future career or study needs as exemplified in this statement:

> I suppose you do ahead of time think about what you want to do, get a bit of a picture in your head of what subjects you need to get into the course you want. (Year 10 boy)

Most students indicated they did not have a clear idea of their future career or study path and that this made subject choice difficult. For example, a Year 11 student stated:

> It's really difficult because none of us really have an idea of what we want to do so you need to be careful to choose subjects that you're going to need as well as the ones you're going to enjoy and that's pretty damn hard. (Year 11 girl)

One student commented that schools could help students by demonstrating the link between subjects and specific degrees as follows:

> If the school had a more direct way of how this influences our future and what it can be used for earlier on, so if we are told how it feeds into a Degree in Engineering or Physics that sort of thing. More linked to how it is useful. (Year 10 boy)

One Year 10 boy indicated he knew which subjects because he had "worked out what I wanted to do since like Year 5" and stated that he wanted to be a doctor.

Students recognised they might change their minds regarding their future study plans and that the study options available to them may be limited by the subjects they chose as exemplified by these two students:

> Unless you know specifically what you want to be you just don't cut out everything because you might decide to change a little bit. (Year 10 girl)

> I really didn't think that Year 10 was the year to focus on universities because you have got another two years. (Year 10 boy)

The next section addresses the final theme of the choice process and presents findings relating to the framework within which students select their subjects.

4.3.3 **Choice process**

The subject choice process was investigated in the focus groups. Students were asked about how they chose subjects for further study, the information sources they consulted, and the people they asked for advice. Figure 4.6 shows the factors influencing the Choice Process node: Choice of subject method, Subject information, Parental influence, Peer or sibling influence, Complexity of choice, and Teacher advice.

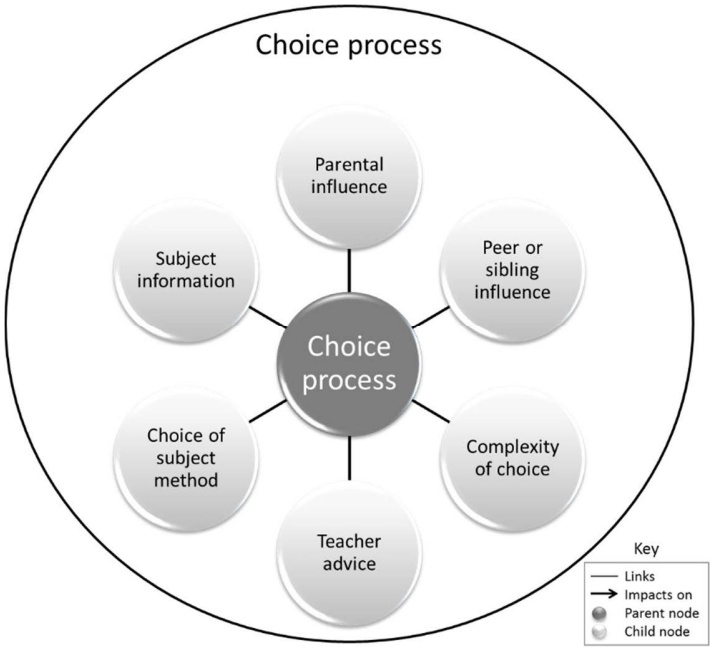

Figure 4.6: Choice process nodes.

Choice of subject method

The subject choice process was consistently described by students as a staged process. In the first stage, most students start by rejecting subjects that they "hate and never want to see again" (Year 10 girl). As noted in Section 4.3.1, students made twice as many comments about disliking subjects as they did about liking them. This suggests that students may start their decision-making process by avoiding disliked subjects.

Students then moved into a second decision-making stage. This stage was directed at evaluating the subjects about which they were unsure. Students included the subjects that they considered to be 'base' or 'core' subjects that they knew they would enjoy. As discussed in Student characteristics in Section 4.3.1, enjoying or liking a subject was a frequently cited factor in choosing subjects. Students who reported poor learning experiences in a subject and did not enjoy a subject typically discarded that subject from their consideration set. As discussed in Section 4.3.1, also important in deciding these core subjects was students' ideas regarding whether or not students believed that they would need the subject in their future career or study path. Although some students may choose subjects that they like before those they dislike, all students responding to questions on their choice process stated that they started by identifying the extremes of liking and disliking subjects.

In the second stage, students researched the subjects they did not feel strongly about in order to determine which of the remaining subjects could fill their allocation of units. The approach for students at this stage was spoken of in terms of finding subjects to study or finding subjects to reject. Students are limited in the number of subjects that they can choose to fulfil their quota of units and approached this decision stage from the viewpoint of either needing to "build up units or trying to cull" (Year 11 girl). The different perspective of looking for subjects to reject or accept appears to be related to whether or not students generally liked a wide range of subjects or very few. The following quotations reflect these two themes:

> I can make them [the units] it's just I'm not too passionate about what I'm doing. Like you're supposed to do everything you love. (Year 10 girl)

> There is an extensive range of subjects I thought and I have only been limited to a few subjects so I thought should I try this, will it be too hard or how will I go with it. I guess I felt like options for the future as well. What are they? (Year 11 boy)

Choosing subjects was usually cited as a difficult process for students unless they had a clear idea of their likely future career or study needs. The extensive range of subjects

available complicated the choice process for most students as expressed by the following student:

> Well, like Science for example, I wasn't doing badly, I was doing quite good. It was just that there were so many options. (Year 11 boy)

Subject information

Students in all focus groups indicated they felt they were well informed by their school about subject choice. No negative comments were made regarding the subject selection information provided to them. One student gave her school the following praise:

> I don't know how much more the school could have done to help us. (Year 10 girl)

Parental influence

Parents were normally consulted during subject selection but the advice was generally about how to choose subjects rather than which subjects to choose. Students made 21 comments that the subject selection advice from parents was general rather than specific. Such advice was similar to advice given to students by their school; that they choose subjects that they enjoy and in which they do well. Five students commented that they had received specific subject recommendations from parents that related to preparation for specific careers or advice to choose Mathematics.

Peer or sibling influence

Twenty-three comments were made by students indicating they consulted with older siblings and friends in higher year groups about subject choices. Specific advice on what subjects to take or avoid was common, particularly with respect to the ATAR and scaling. Some students indicated the advice of older peers or siblings was important in their subject selection as exemplified in these quotes:

> I listen to the teachers but I also have quite a few friends in the year above me so I talked to them a lot as well. So I asked them what they thought and especially girls who were doing similar subjects that I like. (Year 11 girl)

> For me, I went straight to my brothers. (Year 11 boy)

Generally, girls stated they discussed their subject choices with friends whereas boys reported it was ‘not a favourite topic’ (Year 10 boy).

Teacher advice

Teachers were seen to be a biased source of information as they were perceived by students as promoting their own subject. Students commented that they were suspicious of teachers giving advice to choose the subject they taught. For example:

> They pretty much say great stuff about their own subject. Like I think that if you compare like that teacher who is saying how great that subject is, in comparison to someone you trust. (Year 11 boy)

> I was easily persuaded during taster week but then like a week later I was like, hang on a second, I have been brought into their whole kind of selling system and I took a step back and need to think about what I really wanted to do. (Year 10 girl)

Notwithstanding this suspicion, students recognised the expertise of teachers and stated that they listened to general advice about how to choose subjects as indicated by this student:

> The teachers are there to talk to you as well and help to suggest either way what you should do which I found helpful as well. (Year 11 girl)

However, students noted that they would not necessarily follow direct advice from teachers if that advice was the choice of that teacher’s subject. One student stated:

> I was recommended not to drop Science but I decided to anyway. (Year 11 girl)

Students put considerable effort into choosing their subjects and consulted widely. One area where students reported a conflict was with teachers’ views that students might choose subjects in order to study with friends. Seven students objected (animatedly) to the idea that they would choose a subject because a friend was doing it but said that they did discuss their subjects within friendship groups. One student admitted that she would consider a subject in order to study with friends.

Complexity of choice

Students were varied in their comments regarding the complexity of the subject choice decision. Most students commented that they experienced some difficulty in choosing their subjects. This is exemplified by the following response to a question asking students if subject selection was difficult:

> It was. I had to contemplate a lot of things. (Year 11 boy)

Some students found it easy to choose their subjects and stated, when probed, that this was generally because they had already chosen their future study or career path.

The information students were given to assist in their subject selection decision is discussed in Chapter 5.

4.4 Summary

This chapter outlines the findings from the focus groups conducted in four schools. In the focus groups students were asked about their subject choice perceptions and about their choice or rejection of Science as a subject for study in the final years of school. The findings directly address the discovery-oriented research questions:

- What process do students use to decide which subjects to study for Years 11 and 12 at school?
- What factors do students consider when choosing their subjects for years 11 and 12 at school?
- What perceptions do students hold regarding the value of choosing Science for the final years of school?

A discussion within each of these three areas under the headings of process of choice, factors for choice, and choice of science, is presented in this section.

4.4.1 Process of choice

The Focus Group Phase of Fresh Minds specifically sought to develop an understanding of the process students use to choose their subject for years 11 and 12. Figure 4.7 shows a

suggested model for how students approach the subject selection decision making based on their descriptions given in the focus groups.

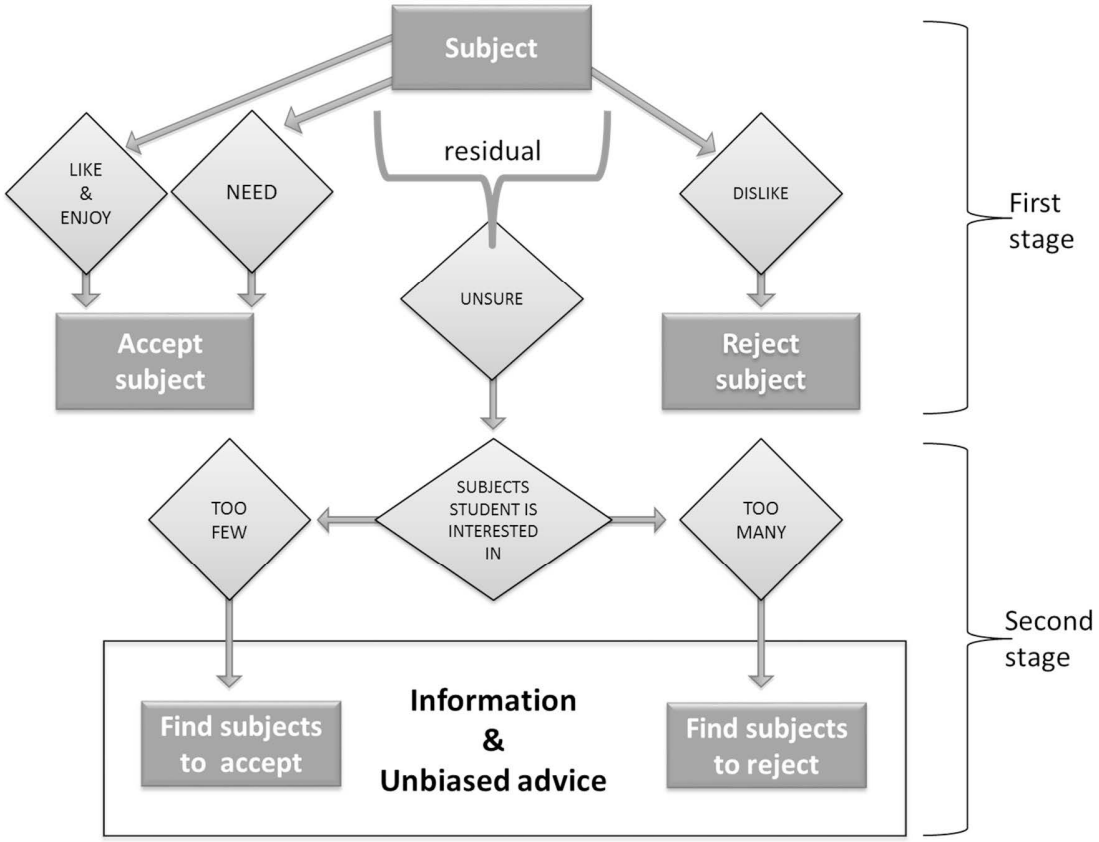

Figure 4.7: Model of the subject choice process that Year 10 students use to select subjects for Years 11 and 12.

The subject choice decision making was described by students of both genders as occurring in two stages: the first involving immediate acceptance and rejection of subjects followed by a second stage requiring a more detailed analysis of remaining options. In the initial stage of decision making, students choose or reject subjects about which they feel strongly positive or negative. They speak of this stage of the process in expressive terms, suggesting

that this immediate acceptance or rejection is a firm view of a particular subject, possibly built up over some time.

In the second stage of the decision making students describe that they engage in a more detailed and rational evaluation of their options. Students at this stage of the decision-making process appear to consider the range of subjects that they are interested in. Students speak in this stage in terms of whether they have too many subjects that they would like to study, or too few. This results in differing standpoints with respect to subject selection; the quest to find sufficient subjects to study if they are interested in too few subjects and the opposing search for subjects to reject if they have too many subjects they wish to study.

As discussed in the literature review for this thesis, adolescents are believed to make decisions based on a collection of cognitive and affective biases which may not be supported by logic (Abelson, 1995; Albert & Steinberg, 2011). If students make their subject choice decisions in two phases, then the bases for these decisions may be very different in each of the stages. In addition, adolescents are believed to have increased sensitivity to their social environment, reduced cognitive control and a greater preference for short-term gains than adults (Blakemore, 2003; Crone, 2009). This would imply that students are likely to choose subjects with reference to the social impact of that choice, be more impulsive than adults, and place more focus on the short-term effort required by a subject than the long-term benefits that may be obtained from studying that subject.

4.4.2 **Factors for choice**

The participating students believed they were making an important decision for their future. The selection of subjects for the final years of school allowed students to choose the subjects that they enjoyed, thought that they would do well in, or would need in later life. It also allowed them reject subjects (except for English) that they felt they no longer needed or did not enjoy. The students expended considerable effort on this decision making and considered a large range of factors to arrive at their selection of subjects. Students have a limited number of subjects that they can study and there are a myriad of subjects competing for their attention.

The reasons students give for choosing or rejecting subjects were varied. Nevertheless, some key considerations appear to be common to most students: enjoyment, past achievement, and usefulness in a career. These findings agree with findings from other similar research in the area of subject choice (Lyons & Quinn, 2010; Nolan, 2012; Venville et al., 2010; Warton & Cooney, 1997). Based on the analysis carried out in this phase, it is suggested that there are seven attributes that students consider in choosing subjects: advice, engagement (enjoyment and interest), logistics, ability (here defined as a student's expectation and experience of achieving high marks), subject characteristics, teaching quality, and usefulness. Within these seven attributes, a list of 21 factors was developed and used in the Survey Phase of this study to further understand how students choose their subjects. These factors were generated by reviewing each node to determine the factors commonly considered by students in their subject choice deliberations. The list was compared with findings from the Environment Phase and compared against factors identified in similar research conducted in Australia (e.g., Lyons & Quinn, 2010; Nolan, 2012; Warton & Cooney, 1997; Whiteley & Porter, 1999). The list of factors is discussed in Chapter 6 as these factors are the basis of BWS component of the Fresh Minds survey.

From the descriptions given by students of the process they use to choose subjects, it is plausible that different factors affect different stages of the decision-making process. Within the first stage of the decision-making process, students use expressive terms about the reasons they chose and rejected subjects. Students speak of 'loving' and 'hating' subjects and so factors that are associated with an emotional response to a subject may be those that affect the decision making of students at this first stage. Factors that were associated with enjoyment or dislike of a subject such as past academic performance and perceptions of teaching may play a greater role in this first stage.

In the second stage of the decision-making process, students describe a more detailed examination of subjects. In this stage it is suggested that more practical aspects of choosing subjects such as a subject's contribution to an ATAR or future career become more important. To students in this study, achieving high marks in subjects was important because they were required for entry into tertiary study. Students were told by schools not to be concerned about the ATAR, yet their responses in the focus groups indicated that they

considered the ATAR very important in gaining access to specific universities and courses. Students referred to the ATAR within the focus groups as if it were currency they were earning to spend on a university course.

Many students were unsure of the career path they may follow. However, these students considered areas of interest, with the apparent view that such areas of interest were likely to lead to a potential career. Nolan (2012) found in a similar study about subject choice, that students' certainty regarding their future career path and interest in a subject were poor predictors of subject choice. The link between knowledge of career path and subject choice is unclear and may involve a number of factors.

Those students who may not have chosen a career path expressed clear ideas about areas they were not interested in pursuing. This lack of interest may be due to numerous reasons, possibly relating to past experience in a subject or a perception that a particular subject has limited use in a student's future – either as a source or of high marks or for a future career.

Students stated they consulted documents from their schools and talked to adults and peers to form judgments about subjects. It is suggested that, if subjects are being considered at this second stage, then the advice of other people becomes an important consideration. Figure 4.8 presents a model of how students perceive the advice they receive when considering subjects.

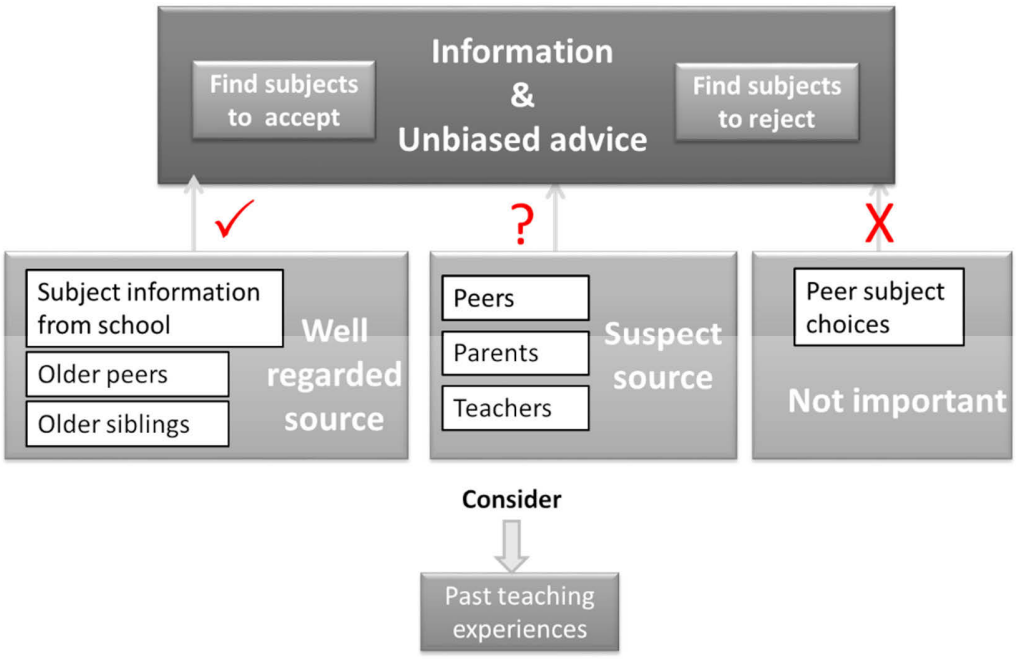

Figure 4.8: Model of how advice is perceived in subject choice.

The influences from adults, family and peers form part of the framework of normative beliefs that impact on a student's intention to choose a subject. Students evaluate advice they receive about choosing subjects with suspicion if it comes from a source that students consider biased; notably, if such advice comes from a teacher recommending their own subject. Students appear wary of being 'marketed' to and resist the notion that they can be influenced by such promotion.

4.4.3 **Choice of Science**

Students appeared to evaluate Science against other subjects in terms of how much they enjoyed and were interested in the subject. This finding was in line with other research in the area of Science choice at school (Lyons & Quinn, 2010; Nolan, 2012; Whiteley & Porter, 1999). Students further valued the subject in terms of its usefulness in a future career and their expectation of the marks they might receive in return for the effort expended on the subject.

Students indicated they believed there was a relationship between subjects that they do well in and those that they enjoy. Science is generally perceived as an onerous subject where obtaining high marks is more difficult than for other subjects. However, students appear to consider extra effort for a subject worthwhile if the subject is needed for their future. Students did not indicate that they sought less challenging subjects *per se*, simply that the subjects studied should be of sufficient value to a student's career or future study needs to warrant such effort. Interestingly, other research has shown that academic proficiency is a predictor of subject choice but interests are not (Nolan, 2012).

Figure 4.9 shows a proposed relationship between the engagement (enjoyment and interest) and ability in Science in the subject selection decision. Students indicated that they would generally not study a subject that they did not enjoy or felt they would not achieve high marks in. Students also suggested there was a link between engagement in a subject and their performance in that subject. The model is based on these findings and suggests that enjoyment of Science leads to consideration of the subject for future study, but such choice is ameliorated by the student's assessment of their ability to achieve academically in the subject. Overriding this decision is the student's belief that enjoyment of a subject will improve their likelihood of obtaining high marks.

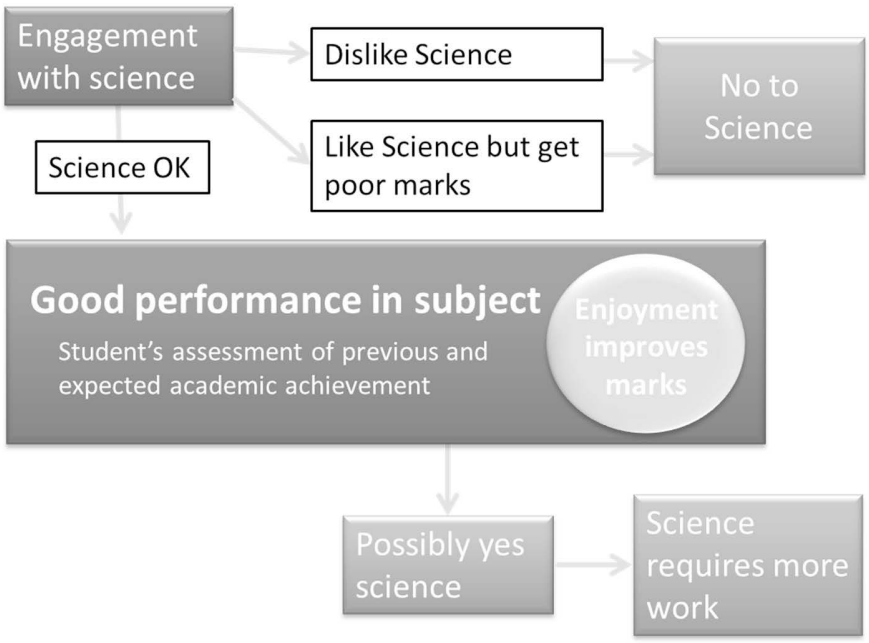

Figure 4.9: Relationship between engagement and performance in Science choice.

Students indicated there is a relationship between their experiences of past teaching and enjoyment of a subject. If this is so then this has implications for ensuring a consistent positive experience in the Science classroom in the middle years of schooling. This would particularly be important if students have had poor teaching experiences given that people react more strongly to negative experiences than positive ones (Baumeister, Bratslavsky, Finkenauer, & Vohs, 200; Shafir, Simonson, & Tversky, 1993). Figure 4.10 shows the proposed interaction between past teaching experiences and the decision to choose Science. In this model, poor classroom experiences in Science or a strong dislike of a potential teacher are proposed reasons for rejecting of Science. It is suggested that students who have not been turned away from Science by negative classroom experiences will consider the teaching of the subject in terms of the quality of the teaching they believe they will receive and how this translates into good marks. This model suggests that the support of teachers to enable students to achieve good marks may lead to enjoyment of Science.

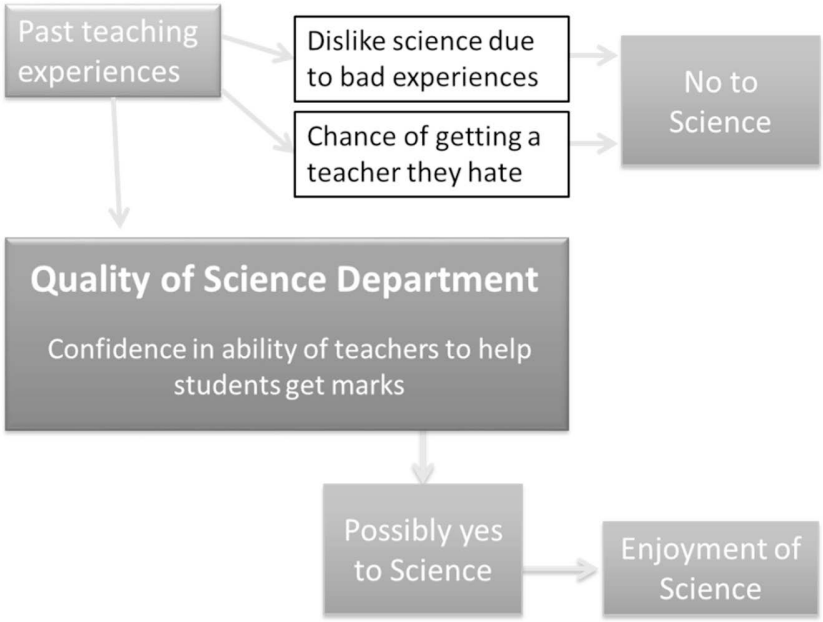

Figure 4.10: Model of how past teaching experiences affect the choice of Science.

The view that Science is a subject that is only useful for traditional science- or engineering-based careers was widespread amongst the participating students. Students' perceptions that Science is required for a narrowly defined range of occupations may limit the subject's attractiveness. The general use of Science as a means to building analysis and argumentation skills and the value of these skills in a range of occupations was not obvious to these adolescents.

The proposed interaction between the perceived difficulty of Science and career choices in the decision to study Science is shown as a model in Figure 4.11. This model links the student's perception that Science subjects require more work than competing subjects to a student's need for Science for a future career. It suggests that students are assessing the value of Science in terms of whether it is worth undertaking the additional effort they believe Science demands.

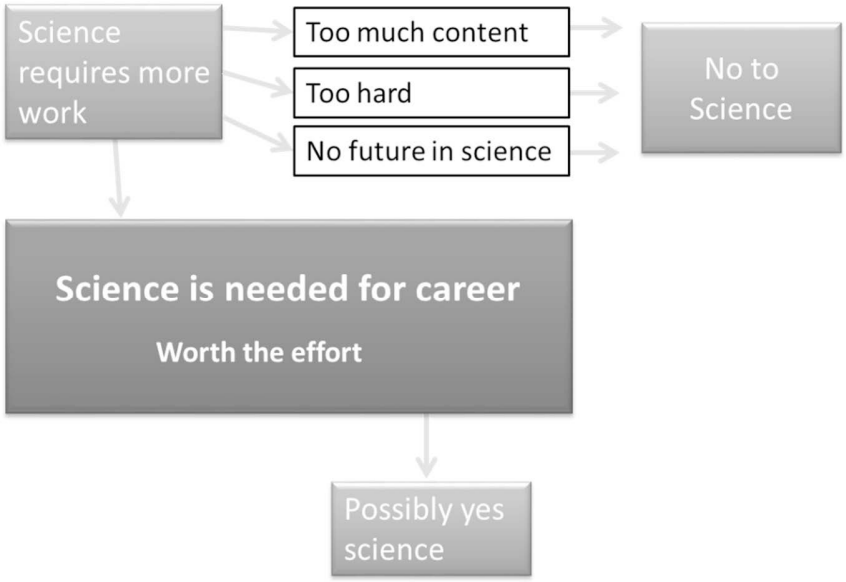

Figure 4.11: Model of the role of career in choosing Science.

Some students indicated that they considered 'liking science or not' as a characteristic of an individual's personality rather than a study preference. The idea expressed was that there were certain innate characteristics that identified a person as one who was attracted to Science. The idea of the general usefulness of Science and how it is perceived by students is discussed in Chapter 7.

This chapter presented findings from the Focus Group Phase and proposed a model for the process students used to decide which subjects to study for Years 11 and 12 at school. The factors students consider when choosing their subjects were investigated and these factors were grouped into seven attributes that students consider in choosing subjects. Finally, the perceptions of students with respect to the choice of Science for future study suggest that the factors of enjoyment, engagement, ability, teaching quality, and usefulness may play a particular role in the acceptance or rejection of Science.

Chapter 5 will describe the environment within which students make their decisions about subjects and the views of adults involved in assisting students in their choices.

CHAPTER 5: **Environment Phase**

5.1 Introduction

The previous chapter suggested a model for subject selection and choice of Science based on findings from the 10 focus groups conducted with 50 students at four schools. This chapter describes findings from the Environment Phase of the Fresh Minds study, which examined the written and verbal information provided to students to help them choose their subjects for Years 11 and 12. This phase addressed the discovery-oriented research question: What information are students provided with to assist them in choosing their subjects for Years 11 and 12 at school and how is this information assessed by them?

In the Environment Phase, seven subject selection events were observed at four schools and all the documents given to students at these events were reviewed. Semi-structured interviews were held with 15 adults within these schools who were identified by school representatives as being in a position to influence student subject choice.

The remainder of this chapter comprises three sections. Section 5.2 describes the content and presentation of the subject selection information provided to students. Section 5.3 presents an analysis of interviews with adults within the school who were in a position to inform students on subject selection decisions. The final section, 5.4, provides an overview of the key findings in this chapter.

5.2 Subject choice information

This section describes the information presented to students to assist them in their choice of subjects. It provides information on the number of units to be studied, the subject selection events, written information provided to students, and the careers information provided to them. The purpose of the content analysis in this phase of Fresh Minds was to understand the specific context within which students made their subject selection decisions.

5.2.1 **Number of units**

Students' subject choice was influenced by the rules relating to the number of units of subjects that students were permitted to study. For successful completion of the HSC a minimum of 12 units must be studied in Year 11, and a minimum of 10 units in Year 12. Subjects are typically worth two units. See Appendix A for summary of the BOSTES Higher School Certificate rules.

Within this study each school had different recommendations or limitations on the number of units students could choose in Year 11. The government girls' school allowed students to take more than the minimum number of units (12 units) defined by the HSC rules. However, the school representative at this school stated that they discouraged additional units because each unit required students to commit to an additional eight hours of school work each week. The government co-educational school did not permit more than 12 units. The three non-government schools all recommended that students study a minimum of 13 units. Each of these non-government schools had different rules for students studying 14 units. One of these schools recommended the study of 14 units, one school recommended 14 units only for those with demonstrated ability, and the third school did not allow students to study 14 units.

School representatives indicated that the schools' reasons for limiting the number of units students could choose was the schools' limited ability to timetable additional subjects and provide teaching and other resources. They also stated that they limited the subject load that students could undertake to prevent students from exceeding their capacity.

An additional rule applied to students attending two of the participating non-government schools. These were faith-based schools and each required students to study a religion subject. One of these schools required students to study at least one unit of the BOSTES approved subject Studies of Religion. The other school gave the students the choice of the BOSTES Religion subject or a school-based religion subject that was outside of the requirements of the HSC.

5.2.2 **Subject selection events**

Schools organised events to inform students about the mechanics of subject selection and provide information on the range of subjects available at the school. Each school held an evening event (variously named but termed 'subject selection information night' for this study), for parents or guardians to attend with the school student, that outlined the rules of the HSC and the school's subject selection processes. In four of the five schools, a separate information event was held for students only (referred to as the 'subject information event' for this study). This subject information event informed students about the subjects they could choose. The fifth school, the non-government boys' school, combined the subject information event with the subject selection information night and both parents or guardians and students were invited to this event. The events were compulsory but attendance was not taken. Table 10 lists the events held at participating schools.

Table 10: Subject selection school events

School type	Event(s)	Format of event
Government girls	Subject selection information night	Information evening for students and parents presented by school staff.
	Subject information event	Subject selection presentations by subject teachers during class time. Students move from classroom to classroom to hear all presentations.
	Survey	Initial survey to assess subject intentions used to create a draft timetable and determine subjects to be offered.
Government co-educational	Subject selection information night	Information evening for students and parents.
	Subject information event	In-school presentations by teachers on subjects Students move from classroom to classroom to see presentations on subjects. Students attended all subject presentations.
	Careers program	Digital information provided on careers program.
	Career lessons	Fortnightly career/subject selection lessons.
	Personal interviews	Teachers met with students to discuss choices.
Non-government boys	Subject selection information night/ Subject information event	Group presentation in main hall describing subject selection process followed by subject presentations in classrooms around the school. Students chose which subject presentations to attend.
	Careers testing	Formal careers testing. A report including suggested vocations was provided to students.
	Personal interviews	Teachers met with students one-on-one to discuss choices. The teacher may not be a teacher of the student.

Table 5.1: Subject selection school events (continued)

School type	Event(s)	Format of event
Non-government girls (1)	Subject selection information night	Information evening for students and parents presented by school staff.
	Subject information event	Subject market consisting of stalls around the hall from different faculties. Students chose which stalls they wished to visit and could gather pamphlets on each subject and ask questions of teachers.
	Careers testing	Formal careers testing by an external provider. A report including suggested vocations was provided to students.
	Personal interviews	Students met with teachers or school administrators one-on-one to discuss their subject choices. The teacher or administrator may not know the student personally.
	Podcasts	Podcasts (5 min) describing each subject were made available through the school intranet.
Non-government girls (2)	Subject selection information night	Subject selection information evening presented by school staff and a university marketing/admissions representative who described HSC requirements and university entry.
	Subject information event	A group presentation was given in the hall to all students followed by stalls around hall from different faculties. Students chose which stalls they wished to visit and could gather pamphlets on each subject and ask questions of teachers.
	Careers testing	Formal careers testing. A report including suggested vocations was provided to students.
	Personal interviews	Students met with teachers one-on-one to discuss their subject choices. The teacher was known to the student.

Students choose their subjects at different times during the school year. In the Australian school year these are four terms each of approximately 10 weeks. At three of the schools in this study, subjects were chosen for the HSC midway through Term 3. Students at the other two schools chose subjects during Term 2.

All subject selection evenings and events at the participating schools were attended by the Researcher except for the Government co-educational school. At this school subjects were chosen prior to the school agreeing to participate in the study.

Subject selection information nights

The subject selection evenings that were observed at the four participating schools followed a similar format. After an introduction, schools provided details on the requirements for successful completion of the HSC and the calculation of the ATAR. The school's specific method of subject selection and the timeline for subject selections was then outlined.

Students were provided with general advice about what factors they should consider in choosing their subjects. Broadly, each school advised students to choose subjects for which they had ability, interest and motivation, career aspirations and/or that they would need for future study. Presenters cautioned students about choosing subjects based on the choices of their peers but advised them to ask older siblings about the effort required for subjects they were considering. Schools also told students to take into account practical issues such as syllabus requirements, practical or major work components, which subject combinations may work well together, and the importance of keeping future study options open when choosing their subjects. Schools typically advised students that the ATAR was "complicated" and students should just "do your best" (Non-government girls' school (2)). One of the non-government girls' schools also provided a speaker from a university who informed students about bridging courses, scholarships and bonus ATAR points available to some students wishing to attend that university.

In the three non-government schools, the Careers Adviser also gave a short talk on subject selection and university requirements. These Advisers invited students to make contact to discuss their subject choices. However, in one of these schools the careers adviser noted that due to demands of the Year 12 students, she would be unable to see students prior to the subject selection deadline. At another school the students were told that during their life they will have minimum of five different careers and have over 20 jobs, and the Career Adviser suggested that it was important that students not restrict themselves to a particular career for the purposes of subject choice.

In addition to outlining the rules for choosing Science for the HSC, Science was mentioned at presentations given at the two non-government girls' schools. At one of these schools, a reference was made to the necessity of choosing Chemistry at school if students

were considering studying a medicine-related degree. At the other school, the presenter stated that she personally had not chosen Physics because she was good at English. This statement was part of a discussion on scaling of subjects in the calculation of a student's ATAR (see Appendix A for a description of the ATAR and scaling). The presenter encouraged students not to choose subjects based on scaling by using the example that choosing Physics on the basis that this subject had previously be preferentially scaled was inadvisable. The university representative who spoke at one of the schools advised students that there were no course prerequisites for that university and that the university had bridging courses in Mathematics, Chemistry and Physics. The representative advised that these bridging courses were, "challenging".

At the subject selection information night at the non-government boys' school, Science was mentioned in two contexts outside of HSC rules. On one occasion boys were told that they should take a Science if they planned to enter medicine. On the second occasion students were told they would require extension Mathematics if they were planning to study Physics or Engineering. Students were also told that extension Mathematics (three or four unit) was only offered to advanced students which were defined by the speaker as being "the top 70 students".

No comments were made at the government girls' school about Science outside of references to the HSC rules.

Subject information events

Subject information events provided specific information about all subjects and an opportunity for students to ask teachers specific questions about them. These events were presented in a variety of formats but all started with a presentation to all the students about the purpose of the event. After the introduction, information was provided on each subject area as either a presentation by teachers, to smaller groups, or via stalls staffed by teachers that students could visit. Table 10 describes the formats of these events at each school.

Typically, subject presentations contained a description of the subject, the assessment requirements, and an outline of the benefits to the student of studying the subject. Students were always provided an opportunity to speak to teachers. They were

usually provided with leaflets describing key features of each subject. All Science subject information talks were attended by the Researcher.

Both of the non-government girls' schools provided a subject selection 'marketplace' to inform students about the subjects available. These subject information events commenced with a brief group introduction after which students could move around a hall to visit stalls set up by each faculty. The Researcher visited each stall. At most stalls leaflets describing the subjects offered within the faculty were provided and students asked questions of teachers. The stalls with the greatest number of student visitors were English and Science.

Students asked questions at the subject information talks and stalls. The questions asked at talks were general and those at the stalls were usually specific. General questions involved clarification on the subject content and assessment. The Researcher noted the types of questions asked of teachers at the science and English stalls. Students typically asked English teachers which level of English they should do. The Science teachers were commonly asked questions about the difference between sciences subjects and which Science the teacher would recommend for the student. Students were not observed to ask teachers at these stalls whether they should choose a Science.

Personal interviews

All participating schools except for the Government girls' school also conducted one-on-one interviews that provided students with an opportunity to discuss their subject choices with a teacher or school administrator (typically the Head of Department or Head of Senior School). These interviews normally lasted 10 minutes and students were questioned on the rationale of their subject selection and interviewer would make recommendations on student subject choices if required. The interviewing teacher or administrator was not necessarily one of the student's teachers and these interviewers would refer students to their teachers to discuss specific subjects.

All schools encouraged students to speak individually with teachers about their subject choices. The advice students received is discussed in section 5.3.3.

5.2.3 **Written information**

Students at each school of the four schools where subject information events were observed received booklets to assist them in their subject selection for the HSC.

Students were provided with a copy of the University Admissions Centre (NSW and ACT) Pty Ltd (UAC) booklet, *University requirements 2016 for Year 10 students* (University Admissions Centre, 2013). The UAC booklet states:

> This booklet is for Year 10 students choosing their subjects for Years 11 and 12. Its aim is to help you think about the next two years and beyond and provide information so that you can make the best decisions for successful senior school and tertiary study (University Admissions Centre, 2012, p. 3)

The booklet explains the HSC and how to apply to university, as well as a framework for considering subjects for study. A number of other UAC booklets were also often provided to these students. These booklets provided similar information to that in the Year 10 booklet.

Students were also provided with a school-produced booklet that gave an overview of the requirements for completing the HSC. The handbooks from the schools were similar and described each subject offered by the school and subject information.

The layout of the Chemistry subject page in three of the subject information booklets is shown in Figure 5.1. At three of the schools, each subject was presented by one A4 page of text. The non-government girls' school (2) used two pages per subject. This booklet is in the centre of Figure 5.1.

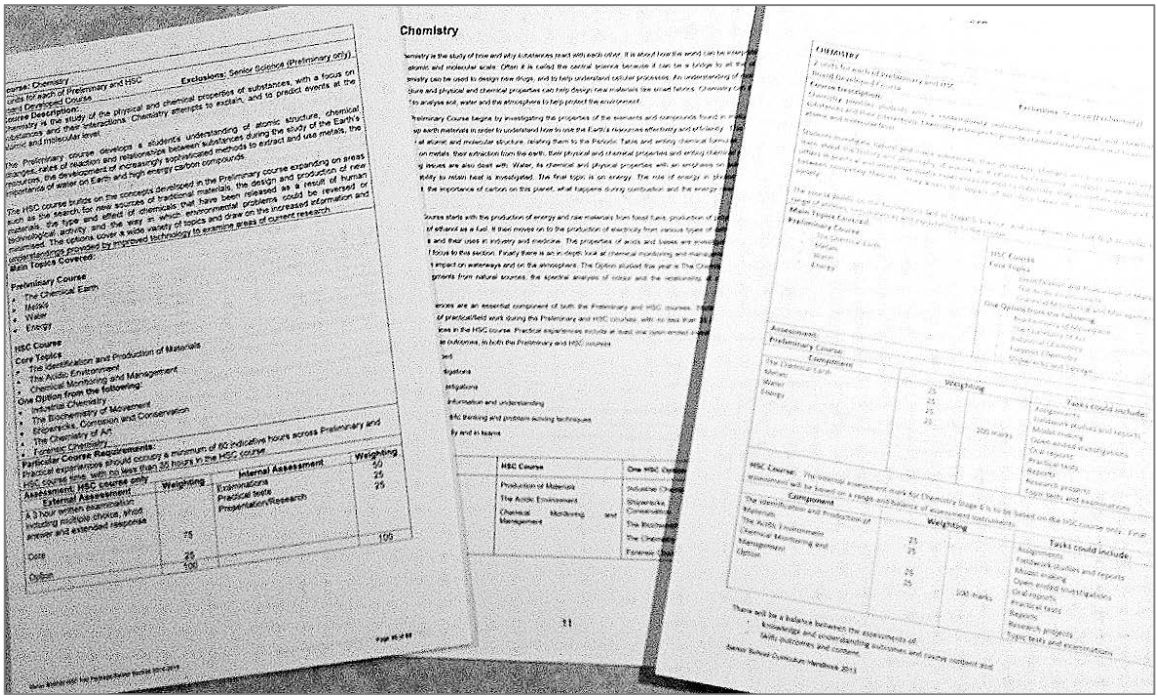

Figure 5.1: Format of Chemistry pages in school subject selection handbooks.

A course description was provided for each subject that included a list of topics to be studied. The style of information in the booklets was similar. For example, the description for Chemistry in each of the booklets was:

- Chemistry is the study of chemical properties of substances, with a focus on substances and their interactions. (Government girls' school, *The Higher School Certificate: An information package for students*, nd)
- Chemistry provides students with a contemporary understanding of the physical and chemical properties of substances and their interactions. (Non-government boys' school: *Years 11&12 Curriculum Handbook 2013*)
- Chemistry is an experimental science that combines academic study with the acquisition of practical and investigative skills. (Non-government girls' school (1), *Years 11&12 Subject Handbook 2014-2015*)

- Chemistry is the study of how and why substances react with each other. (Non-government girls school 2, 2014 Year 11 Subject information guide)

The Science subject descriptions in the subject information booklets from participating schools were similar and for two of the schools the texts were largely identical. The text relating to the usefulness of Chemistry from the information booklets is presented in Table 11. A Google search of the two statements common to the two schools shown in Table 11 revealed this statement has been used by at least seven NSW schools in addition to the two schools that participated in the Fresh Minds study. This finding suggests that booklets from many other schools may contain similar information to booklets from participating schools.

Table 11: Subject selection handbook comments on usefulness of Chemistry

	Government girls' school	Non-government boys' school	Non-government girls' school (1)	Non-government girls' school (2)
Statements indicating the usefulness of science to the student	[Chemisty] develops a student's understanding of atomic structure, chemical changes…search for new materials…the way in which environmental problems could be reversed or minimized…examine areas of current research.	They assess the impact of decisions based on an understanding of Chemistry on society. Chemistry provides students with a contemporary understanding of the physical and chemical properties of substances and their interactions.	They assess the impact of decisions based on an understanding of Chemistry on society. Chemistry provides students with a contemporary understanding of the physical and chemical properties of substances and their interactions.	[Chemisty is how the] world can be interpreted…design new materials…analyse soil, water and atmosphere to help protect the environment.
Skills explicitly stated		[Chemistry is to] undertake experiments and decide between competing theories.	[Chemistry is to] undertake experiments and decide between competing theories.	[Chemistry is] Planning investigations. Conducting investigations. Communicating information and understanding. Developing scientific thinking and problem-solving techniques. Working individually and in teams.

The subject information for non-Science subjects was generally similar to that provided for Science subjects. However, some of the descriptions varied in style. For example, the Business Studies description from the non-government girls' school (2) stated: "The role of incentives, personal motivation and entrepreneurship, especially in small business, is recognised as a powerful influence in business success." The description of this subject was directed at informing students of the benefits they would obtain from studying Business Studies. The Science descriptions did not illustrate the usefulness of Science to students.

In addition to a subject selection handbook, the three non-government schools provided students with leaflets on individual Science subjects. These leaflets were made available to students at subject selection events and described the key areas covered by the subject syllabus and the student attributes required for the subject. Some provided website URLs where additional information could be accessed. The information on the leaflets was more detailed than the information in the handbooks and included pictures or diagrams. Samples of leaflets provided to students are shown in Figure 5.2.

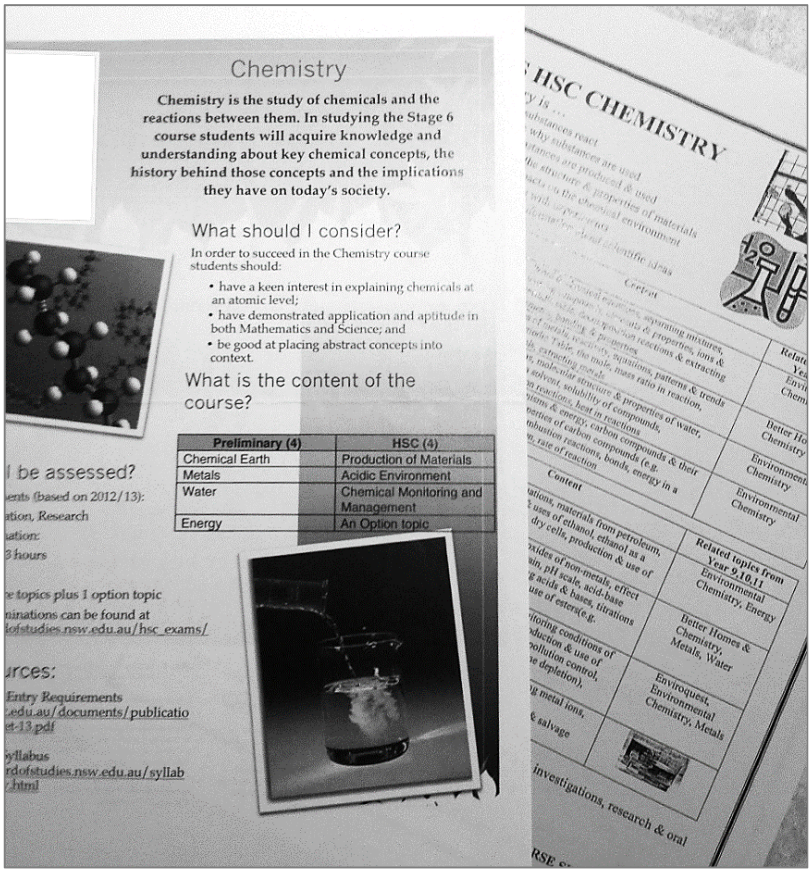

Figure 5.2: Format of Chemistry subject selection information leaflets.

Leaflets provided detail on the content of the subject but, in addition, the leaflet from the non-government boys' school contained a section describing the requirements for success in Biology as follows:

> In order to succeed in the Biology course students should:
>
> • have a keen interest in explaining the living world around them;
>
> • demonstrate application and aptitude in Science and
>
> • be able to place abstract concepts into context.

5.2.4 **Careers information**

Students were provided with career profiling and/or access to a service that allowed them to investigate the suitability of potential careers. Students at non-government schools completed career profiling which involved the completion of and resulted in a report given to students that suggested a range of careers based on their responses. Students at the government schools were directed to www.careersworks.com, a website subscribed to by the school that had been developed by a Careers Adviser. The *Careersworks* site allowed students to investigate career and study options.

Students at both of the government and non-government schools were directed to consult www.myfuture.edu.au, a government website designed to assist students and parents identify potential careers. The *Myfuture* website provides a basic profiling tool and suggests careers based on a career profile created by the student. This tool requires students to select interests and activities and allows them to choose between 42 pairs of areas of study such as ‘’Chemistry’ v ‘Electronics’ and 21 activities such as ‘Manage a Library’ or ‘Work in a Science Lab’. The website states that the more pairs that a student chooses from, the more useful the site would be at determining the student’s interests. On investigating these options within the website the Researcher found that all of the science-related options needed to be selected before the website would offer science as the most prominent interest. If science was the most prominent interest then the website recommending stereotypical scientific careers with the following advice: “You like to discover ideas, observe, investigate and experiment. This includes medical and health occupations. Doctors, pharmacists, zoologists, dentists, chemists and physicists have high scientific interests” (Commonwealth of Australia, 2013).

Career information through the school Careers Adviser was available to students at each participating school. Year 10 students’ contact with the Careers Adviser was typically associated with key events such as career profiling, work experience organisation or more general career information events also aimed at Years 11 and 12. Careers Advisers in four of the schools were highly active, providing comprehensive information on a range of careers and stated that they had an ‘open door’ policy with respect to student contact. The

Careers Adviser at the fifth school was not regarded highly by students, with one student stating in the focus group at this school:

> I didn't talk to the teachers [about subject choices] and I would have gone to the Careers Advisor but she likes to destroy people's dreams.

The other students in the focus group nodded agreement at this statement.

Career Adviser services were in high demand within the four schools where the adviser was well regarded. Careers Advisers noted that although services were offered to Year 10, limited resourcing meant that most career advice was directed at Years 11 and 12. Year 10 students were invited to career events organised by the school or offered externally. The Researcher observed three of these careers events and noted that they were directed at Years 11 and 12. Further details of career advice is discussed in section 5.3.1.

This section described and analysed the subject choice information given to students and the means by which that information was delivered to them. The next section describes interviews held with adult stakeholders within schools.

5.3 Adult interviews

The Researcher interviewed adults within all five participating schools in order to understand their role in helping school students choose their subjects. These interviews were conducted after the student focus groups had been held at each school so that students' perceptions of subject choice could be compared to adults' perceptions.

Fifteen interviews were conducted with adult stakeholders who had been identified by school representatives as playing a role in career or subject selection. Table 12 provides information on the adult stakeholders interviewed.

Table 12: Interviews with adult stakeholders within schools

School type (code)	Role	Gender
Government co-educational	Careers Adviser	Female
(GC)	Deputy Principal/teacher	Male
	Head of Science	Male
Government girls (GG)	Deputy Principal Curriculum	Male
Non-government boys	Careers Adviser	Female
(NGB)	Head of Science	Female
	Science Teacher	Male
	House Master/Teacher	Male
	House Master/Teacher	Male
	House Master/Teacher	Male
Non-government girls 1	Deputy Principal Curriculum	Female
(NGG[1])	Director of Senior School	Female
	Head of Science	Male
Non-government girls 2	Careers Adviser	Female
(NGG[2])	Head of Science	Female
5 Schools	15 Interviews	8 Male 7 Female

Analysis of the adult interviews

As outlined in the Section 3.4, the adult interviews were semi-structured, with the discussion guided by key questions. The adults were asked for their views on how students chose subjects and how students considered subjects, particularly Science. Interviewees were asked about the factors they believed students considered in their subject choice decision making and how they used the information and advice provided to them. The adult interview were analysed with reference to the themes identified in the Focus Group Phase: student characteristics, subject characteristics and choice process. These themes are discussed in this section.

Quotes from interviewees presented in this section are identified by listing the role of the adult stakeholder, the school type (as indicated in Table 12), and M or F to indicate the gender of the interviewee. Therefore a quote from the female Careers Adviser at the government co-educational school would followed by the identifier *Careers Adviser GC F*.

5.3.1 **Student characteristics**

In this first theme, the analysis of adult statements about subject choice that related to the characteristics of the student is presented under two headings: enjoyment and ability, and teaching.

Enjoyment and ability

Most interviewees considered enjoyment and interest in a subject to be important factors that students should consider in choosing subjects. This aligns with comments made by students in the Focus Group Phase of the study, who repeatedly stated the importance of interest and enjoyment of a subject in selecting subjects.

One interviewee *(Head of Science NGG[1] M)* noted the variation in enjoyment of Science he observed as students progressed through middle school. He stated that there was a fall in enjoyment related to the transition of the subject from being, "fun and practical and they are explaining things" to the position in Year 10 that he described as a, "watershed moment" when some students decide, "I'm just not getting anywhere with this, it's not for me".

The ability of the students to obtain good marks in a subject was also commonly cited as an important consideration in the subject choice decision making. The record of achievement of previous HSC students who attended the school was also mentioned as a driving factor. The Head of Science at the Non-government girl's school (2) said:

> They will very much look at the record of the school, how many band 6s and band 5 [HSC mark of 80% or over] and that sort of thing. They will be very driven by that as well as opposed to just their interest and ability in a subject.

A House Master/ Science Teacher at the Non-government boys' school commenting on the relationship between ability in Science and selection of a Science subject stated that students informed him they did not choose Science because, "when I was in Year such-and-such I was hopeless" and this teacher believed that students had already developed a view of their science capability by Year 9. Comments relating to ability were often related to the need to obtain the mark necessary to generate a high ATAR as discussed in section 5.3.2.

The adults interviewed at the Government co-educational school offered a different perspective on the relationship between ability and choice of a Science subject from adults in other participating schools. The Government co-educational school had a large proportion of students (approximately 80%) from Non-English Speaking Backgrounds (NESB) and most of the students at this school chose a Science. This choice was regardless of whether students had previously performed well in the subject. The Head of Science stated that for students who had not shown ability in Science:

> I'm looking at discouraging them because three months into the course they're in tears going "I can't do it." *Head of Science GC M*

The Deputy Principal also stated that some Year 11 and 12 Science students would, "probably be better suited to doing other subjects" and that the school was experiencing, "trouble breaking down that culture [amongst NESB families] that says that if you are planning to go to university you must do Physics and you must do Chemistry" *(Deputy Principal/ Science Teacher GC M).*

Teaching

Students' experiences with the teaching of subjects at their school was considered an important factor in students' choice of subjects. Adults' comments on the effects of students' previous experiences of being taught, and their expectations of teaching quality on subject choice, are considered in this section.

The adults interviewed made clear statements about the importance of teaching to a student's choice of a subject. Adult understanding on the impact of previous teaching experiences influencing students' opinion are evidenced by the following comments:

> You know a lot of it happens at the coal face. It depends on who's in front of them - the impact of the teachers is huge. *Head of Science GC M*

> I think the missing factor is, the one we haven't spoken about, is the quality of the teacher. I can't overemphasise how crucial that is. *Deputy Principal and Science teacher GC M*

> I think so much of [liking Science] depends on the teacher. *House Master/ Science Teacher NGB M*

In one case, the interviewee considered experiences with previous Science teaching to be the most important factor in choosing Science, saying:

> Well, that is what they are going to base their decision on in Year 10, isn't it, on what their experience [in Science] is. *Deputy Principal Curriculum GG M*

The following statement exemplifies comments from four interviewees on the negative influence of previous teaching experiences on Science selection:

> As far as they're concerned, they've had a bad experience here, my teacher wasn't interesting or whatever and so that's gone. *House Master/ Science Teacher NGB M*

An adult from the non-government boys' school commented that if, during middle school, boys were exposed to Science teachers who showed dislike for particular strands of Science then it becomes less likely that any Science subject would be chosen. He said:

> So if you have a boy, who in Year 8 had a teacher who wasn't particularly fussed on chem, Year 9 wasn't fussed on Physics and Year 10 wasn't fussed on bio you've basically knocked everything out. *House Master/ Science Teacher NGB M*

A further aspect of choosing subjects was students' anticipation of which teacher they would be allocated should they choose a particular subject. Several adults noted that students often enquired about who would be teaching specific subjects. One said:

> Well, they certainly think about who the teachers are in Years 11 and 12…we're at great pains all the way through Year 10 to tell them that we have absolutely no idea who the teacher is. *Director of Senior School NGG[1] F*

Participating schools did not inform students who would be teaching individual subjects when subject selections were made in Year 10. However, if the science faculty was small, students could infer who their teacher was likely to be. Two interviewees noted that some students considered the chance of being allocated a teacher who was perceived to be poor to be a sufficient reason or not choosing a subject. One commented:

> The kids are not silly and they know that if there are three Physics teachers and they know who those teachers are, then it's likely that if two of them were no good, for example, that

> that might be enough to turn them off doing Physics. *Deputy Principal/ Science Teacher GC M*

As shown in the following quotation, the impact of the teacher who might be allocated to a particular class on a student's choice of subject was considered important:

> I think that if we told them who the teachers were, that some subjects would go up and some subjects would go down and I firmly believe that. *Deputy Principal Curriculum GG M*

Within some schools, students who wanted to change class were permitted to do so, although this was not commonplace. Adults stated that such requests were not unusual but that changing class required there to be a specific issue. For example:

> Boys will sometimes come and try and change classes… But as a House Master and I go and see (Head of Curriculum) and I say you know I think there is an issue with this boy, they will change them if they can. *House Master/ Commerce Teacher NGB M*

At one school, parents also approached schools to request certain teachers for their child. One interviewee stated:

> You get some parents and students who will fight tooth and nail to get into a particular teacher's class. I don't think we're ever going to change that. *Head of Science GC M*

5.3.2 **Subject characteristics**

The second theme emerging from the adult interviews are views regarding the characteristics of subjects and how these characteristics influence a student's subject selection. This will now be explored with reference to the adults' statements related to the logistics of students choosing subjects, the difficulty of subjects, and career factors.

Logistics

Limitations in the number of units students could choose was cited as an issue for some students. The restriction on undertaking extra units in the government co-educational school concerned some students and their parents. The two interviewees at the Government co-educational school commented:

> I have a lot of conversations with parents who want their child to do 13 units or 14 units and they can be quite heated discussions actually. *Deputy Principal/ Science Teacher GC M*

> The selective stream are always whinging to me that they aren't allowed to do any more than 12 units and it's a timetabling issue. *Careers Adviser GC F*

Students' desire to study more units than permitted by the school was not mentioned as a problem at the other four schools.

Two adults stated that they advised students to consider the format of assessment for subjects when making subject selections. They said:

> A lot of them try to do too many practical subjects. We don't allow them, well, we strongly discourage them from trying to do more than two subjects that have a major work. *Careers Adviser, GC F*

> [A way to choose subjects is to] look at your pattern of study so if you have a lot of subjects that may involve essay writing – you've got three hours of writing, writing, writing. *Head of Science NGB M*

Difficulty

The perceived difficulty of a subject was noted by adults as a factor in subject choice. Adult interviewees at all schools believed that students saw Science subjects as being more difficult than other subjects. This is exemplified in the following quotes referring to Science subjects:

> I think they are perceived as being quite difficult subjects. *Deputy Principal Curriculum GG M*

> I think they think it's hard and they either love it or they hate it. *Careers Adviser NGG[2] F*

> They are not straightforward subjects. *Deputy Principal Curriculum GG M*

Three adults stated that they believed that students' perceptions of Science as being difficult and content laden were justified. This belief was typified by the following comment:

> I think they perceive that it is a difficult subject. I think they also perceived, and probably quite correctly, it is quite loaded. It's very intense, content laden. *Head of Science NGG[2] F*

Offering an alternate view to other interviewees was the Head of Science at the non-government boys' school who, when asked if Science was harder than other subjects, stated that while he preferred not to say that science was difficult, he was "trying to push them on 'if that's your strength then that's what you work on'."

The perception that scientific thinking is an attribute of an individual rather than an ability that can be developed by studying Science was a theme in several interviews. This viewpoint is exemplified in the following comments:

> The concept that Science is a different way of thinking is where "some people get it and some people don't." *Deputy Principal Curriculum GG M*

> [In Year 10] Kids generally know if they are 'sciencey' or humanities. *Careers Adviser NGG[2] F*

These comments mirror similar comments made by students in the Focus Group Phase of the study.

The relationship between the perceived difficulty of Science and a student's perception of their ability to succeed in Science was also discussed in the interviews. Interviewees stated that students thought they would need to work harder to obtain good marks in Science than in other subjects. For example:

> I think they also perceive that they don't get the recognition or the marks at the end of it that they can achieve in another subjects. *Head of Science NGG[2] F*

One interviewee introduced the concept that students' perceptions of their own ability may be negatively affected if they chose a subject that was populated by high performing students. She stated:

> They are also putting themselves into a group of students who are doing Physics who are also very academically able so the competition is almost like they are competing with the 'creams' of that academic ability. *Head of Science NGG[2] F*

This teacher commented that students who are competitive may consider not only their expected performance in a subject, but also their performance relative to that of other students. If this assessment of relative performance is negative, students may be discouraged from studying Science because Science subjects were seen to attract higher performing students.

Two teachers specifically stated that students were trying to maximise the marks achieved for the work they do. One of them said that students wanted to know "how can I get the best marks with the least amount of work" (*Science Teacher NGB F)*. The other teacher said that although some students were looking for an easier option, but that "the reality is that most subjects aren't an easy option" *(House Master/ Commerce Teacher NGB M).*

Career factors

The adult interviewees acknowledged the link between the subjects that students' chose and their future career or study intentions. This link is exemplified in the following quotation:

> I recommend to all the boys to talk to our careers counsellor before they make their subject choices. *House Master/ Science Teacher NGB M*

Teachers and administrators in the participating schools stated that most students did not have a clear idea of their future career path. One interviewee stated that, with respect to surety of career path:

> There are a few [students] that do … know where they are going and what they want to do – what they're aiming for. But I'd say the vast majority don't. *Head of Science NGG[2] F*

This view aligns with the comments made by students in the Focus Group Phase, who commonly stated that they did not have a clear future career path.

Although students may not have chosen a specific career path, interviewees noted that students would have "a pretty clear sort of idea of a field whether it's going to be humanities or it's going to be sciences" *(Deputy Principal Curriculum NGG[1] F).* The lack of a clear career path was thought to concern students, with one teacher commenting "I think that scares them and scares their parents as well" (*Head of Science NGB M).*

A contrasting viewpoint on student's career-choice status was given by two Careers Advisers. These Advisers indicated that most students had a general career direction in mind and estimated the proportions of students who knew their career destination as follows:

> I would say probably 70% have an idea of where they want to go. *Careers Adviser NGB F*

> I would say 90% of them want to go to uni to start off with and the majority of them have an idea of an area that they would like to move into. *Careers Adviser NGB F*

These differing views may be the results of specific enquiries made by Careers Advisers of students concerning their deliberations on career choices as noted in this comment:

> I always ask them where do they anticipate going when they leave school because that does have a bearing on how many units of Maths they need to do, whether it's Science or whatever it happens to be. *Careers Adviser NGB F*

The contradictory view of the two Careers Advisers, compared to other adults interviewed, may also be due to the characteristics of the limited number of students who actively sought out career information in Year 10. It may also be due to Careers Advisers specifically asking students what their career plans were, and so were eliciting a response. Only four students (of 50) in the Focus Group Phase of this study stated that they had sought advice from the Careers Adviser in their school. Students at all non-Government schools had participated in careers profiling and been provided with lists of potential occupations based on that profiling.

Whether or not the adults interviewed believed students were aware of future career and study plans, all of them agreed that most students in their schools were aiming for a high ATAR. The following quotations exemplify this view:

> Because at the end of the day they want to get into a university, into a course and they need an ATAR to do it. It drives them completely. *Science Teacher NGB F*

> I would say as high as 95% or more of our students would be ATAR focused. *Deputy Principal Curriculum GG M*

Adults from two schools noted that students asked for predictions of anticipated the ATARs and that the school did not provide these. Instead, students were thought to access websites that calculate ATAR estimations based on the data students enter themselves. One interviewee commented:

> Most of them go on [the internet] and look at their ATARs and put in 80 across every subject and then and then you push the button and see what you get. *Head of Science GC M*

The method of calculation of the ATAR involves scaling of the marks students receive for different subjects. Scaling is designed to allow courses to be compared fairly by adjusting student marks for subjects to account for the relative differences in the difficulty of individual subjects (www.UAC.edu.au). Most of the adults interviewed stated that they told students not to worry about scaling because scaling changes from year-to-year with the characteristics of a course's cohort. For example, an interviewee stated:

> I try to tell the boys you shouldn't pick a subject because of scaling, that's stupid. It can change any year. *House Master/ Mathematics Teacher NGB M*

One interviewee took a counter view, stating that she did not believe scaling impacted students' subject selection decisions because otherwise "more of them would be choosing Physics and Chemistry you know. So, I actually think that's a bit of a furphy*" (Deputy Principal Curriculum NGG[1] F).* This comment relates to past preferential scaling of Physics and Chemistry which could lead to these subject being more valuable for calculating an ATAR. One interviewee said:

> We have parents saying all the time that Physics scales high. *Deputy Principal/ Science Teacher GC M*

Students in the Focus Group Phase stated that they had received advice from teachers not to choose subjects based on the ATAR and scaling. Nonetheless, they spoke on these topics at length.

Related to the issue of university admission are two comments about university terminology for entry requirements. Australian universities commonly (although not exclusively) use the term 'assumed knowledge' rather than 'prerequisite' to list HSC

subjects that contain knowledge considered necessary for studying specific university courses. This terminology relating to prior knowledge was believed to influence the choice of some subjects, as noted in this comment:

> The universities I think in some ways do themselves a disservice by actually using the language of assumed knowledge rather that prerequisite because if they used the term prerequisite, more students would actually choose to do 2 unit Maths and more students would do Chemistry and Physics. *Director of Senior School NGG[1] F*

Students received contradictory advice from some Careers Advisers relating to the importance of assumed knowledge. The following statements represent the differing views held by Careers Advisers:

> I always tell the kids, if it says 'assumed knowledge' you should be doing it. *Careers Adviser GC F*

> I still have to explain to them that it's the ATAR that gets you in. You know if you happen to have to drop Chemistry or Physics or whatever it is in Year 11 so be it, don't keep it there because you have to. *Careers Adviser NGB F*

All Careers Advisers noted that students' perception of science as a university destination was affected by the minimum reported ATAR entry score for science courses. A low minimum ATAR was seen as indicating a university course was less valuable than courses with higher ATARs. Science was seen as a course with a lower relative ATAR. For example, at the University of Technology Sydney (UTS), the 2014 ATAR cut-off for domestic students applying for a Bachelor of Science course, was 70.7. The corresponding ATAR for a Bachelor of Business was 90, and for a Bachelor of Arts in Communication it was 84.05. Careers Advisers noted that students who had received an ATAR that was higher than they required for their chosen course would sometimes change to a course with a higher ATAR. For example, one Careers Advisers commented:

> When the ATAR is low kids think it's an easy course…They had the perception of the low ATAR. People saying to me "why would I go to Macquarie [University] for 83 when I could go to New South [University of NSW] at 97". *Careers Adviser NGB F*

University entrance requirements were common themes in the adult interviews, with reports that the choice of Science is impacted by students' views of the use of this subject in gaining entry to university. If students do not see science knowledge as a prerequisite for university and see science courses as having lower value (due to the lower ATAR), this may negatively affect students' perception of the value of the Science.

Adults at all schools noted that students "have a very narrow perception of where science may lead them" *(Deputy Principal Curriculum NGG[1] F)* and perceived science as a discipline that led to a narrowly defined range of occupations such as "medicine, engineering, Physics – it's just those roles" (*Head of Science NGB M).*

The choice of Science is seen to be related to student's career intentions. The notion that Science is a subject required for stereotypical scientific roles is exemplified in this quote:

> If they have no great interest in becoming a chemist, a pharmacist or a doctor or something they say "I will do something else". *House Master/ Commerce Teacher NGB M*

According to the adults interviewed, students do not to recognise Science's applicability to a wider range of careers and this is seen as a problem. The following two quotes illustrate this viewpoint:

> They often don't associate science with a lot of career options even though there is science there. I find it really frustrating… You know they don't often associate science to other fields. *Science Teacher NGB F*

> I don't think that they see sometimes realise that broadness that sciences can be applied to. I think they do see it as research with a lab coat. *Head of Science NGG[2] F*

Further, one Careers Adviser stated that *no* students she spoke to said they wanted to study a *general* science degree. The adviser stressed the point during the interview and noted that this was specific to science.

If students were not sure what they wanted to do after school but were not intending to study science specifically, then students were thought to reject Science. This view is noted in the following quote:

> They don't know what they want to do but they're pretty sure it's not science. So they don't pick it. *House Master/ Commerce Teacher NGB M*

The adults' views were supported by students in the Focus Group Phase who repeatedly commented that Science is a subject needed for stereotypical science careers. The students in these groups found it difficult to identify any general use for Science within their everyday life beyond the workplace.

A teacher and a Careers Adviser stated that students may not understand the nature of specific Science subjects offered at the time they make their subject selection decision. The Careers Adviser said:

> Sometimes in Year 10 they haven't got across the Chemistry and the Physics – they study the subjects in different order in different terms so there may be some issues with them not being sure what it is. *Career Adviser NGG^2 F*

The view expressed here was that the teaching of Science in a contextual manner, where the strands of Science are combined, means students did not understand the difference between Chemistry, Physics and Biology. This issue was discussed with the Head of Science during a subsequent interview (non-government girls' school (2)). She stated that they addressed this issue by exposing students to the various science disciplines in order to help them understand the nature of the different Science subjects:

> By the time they are coming to make their decision, their last four topics would have been in those particular strands so that … they are well equipped to say how did I like that, how well did I do in that particular area. *Head of Science NGG^2 F*

5.3.3 **Choice process**

Third and final theme derived from analysis of the adult interviews is the method by which adults believe students choose their subjects. This theme will now be examined with particular reference to the advice students receive.

The Researcher investigated the process by which students choose subjects by asking the adults about the method they believed students used to select subjects and particularly about who they believed influenced this decision making. There was a lack of consensus on how students chose their subjects. This may be because it "varies per student and it depends on what factors are impacting on their decision making" (*Deputy Principal Curriculum GG M*). One interviewee stated:

> I see some girls who have got five subjects and have six in Year 11 and are at a loss as to what to do with the sixth, then I see the other side where I have got kids who have got seven or eight subjects and cannot decide which one not to choose. *Deputy Principal Curriculum GG M*

The lack of agreement between perceptions of how students choose subjects may also be due to the differing roles adults play in informing students and their assessment of the importance of these roles. As noted in the following quote, one Careers Advisers focused on the career information students had received and how this informed student decisions:

> The careers profiling which we just conducted on Friday – this is really the basics for their subject selection. *Careers Adviser NGG[2] F*

Advice to students

The adults were asked about the advice students received about subject choice. These adults stated that students received advice from: Careers Adviser, teachers, peers and siblings, and parents. Each source of advice is discussed in this section.

Each participating school provided students in Year 10 with access to the school's Careers Adviser but there was great variation between schools in the availability and utilisation of this service. One Career Adviser said that it was unusual for students in Year 10 at the school to see her, and in another school the Careers Adviser reported being allocated a fortnightly class with Year 10.

The Career Advisers stated that students asked them questions about scaling and the ATAR, and they believed these questions were related to the students' career intentions.

They also consistently advised students to take a broad range of subjects if they were not sure of their future career path. One interviewer told the Researcher:

> I say, "If you don't know, cover your bases. Do a mixture of subjects. Like, do your Science, do Maths, do humanities and then you're right." *Careers Adviser GC F*

Careers Advisers also gave practical advice to students to help them manage their workload. One stated:

> We try to tell them to pick subjects that can combine. So I tell them in class, if you want to be an engineer, do engineering studies and Physics because they link. Like Biology and PDHPE go hand-in-hand because there is a bit of overlap with those. *Careers Adviser GC F*

Adults interviewed who were not Careers Advisers gave consistent advice concerning subject selection. This is best summed up by:

> The three things that we probably reiterate … is that their choices should be based on what do they like, what do they actually enjoy because they are going to be like motivated if they enjoy and are engaged in something. What are they good at, you know, build on their talents and strengths and then thirdly what might they be doing at university or after school. *Deputy Principal Curriculum NGG[1] F*

Interviewed teachers commented they were often asked by students whether they thought students were capable of undertaking particular Science subjects. Teachers were unsure of whether this advice was heeded. The following remarks illustrate the type of advice students requested from teachers, and how teachers were sceptical about students taking their advice:

> They thing they ask of me as a teacher is 'do you think I can do that?' 'Will I be all right to do Chemistry? *Science Teacher NGB F*

> It's a pinch of salt what the teacher says and a lot of it is built on the relationship with their Science Teacher as well as to what they pick. *Head of Science NGB M*

One teacher stated that he advised students in the top one or two classes to take two Science subjects but that the students did not take his advice. He said, "You don't get much response from that" *(House Master/ Commerce Teacher NGB M).*

There was consistent advice to students who were unsure of their future career path. Two of the interviewees advised students to remain open to changing their minds. They said:

> I guess the message you always say is to keep their options open. *Head of Science NGB M*

> This is why I've given the advice of saying to them, "Well don't close any doors on you"…And you've got that nice broad range. They don't necessarily take that advice on, but lots of them do. *Head of Science NGG[2] F*

One teacher also stated that he encouraged students to consider a range of subjects based on how subjects are assessed rather than only studying subjects dominated by essay-based assessment. He said that he tells students:

> Here we have a subject that's practical based and it's going to test you in a different way so it's actually going to complement all these other humanities and those other subjects that you do. So again I will try to get them out of thinking – it's all about Science and nothing else. They can actually coexist at the same time. *Head of Science NGB M*

The Head of Science at the non-government boys' school said he tells the boys about the importance of getting "as much information as you can, picking subjects for what they are, not what you think they are", He also said he "obviously wants bums on seats but at the end of the day I want the kids to make the best choice for them and if Science is not for them, then it's not for them" (*Head of Science NGB M).*

The recognition that teachers encouraged students to take their classes was acknowledged by an interviewee at another school. She said:

> Let's face it, everybody wants to have the best students in their class so we'll have a teacher say – it's absolutely crucial you do this subject. *Director of Senior School NGG[1] F*

The advice given by teachers and their perception of how students view this advice is consistent with the views of students in the Focus Group Phase. Students stated that they recognised the expertise of teachers and would listen to general advice about how to choose subjects, but they were wary of teachers recommending their own subject. Students

perceived teachers to be biased if they were encouraging students to take the subject they taught and so discounted the value of this advice accordingly.

Adults generally believed that students both consulted, and listened to advice from, peers and siblings. In response to the question "Do students listen to their friends?" three interviewees commented:

> Oh yes, enormously, massively. *Director of senior school NGG[1] F*

> I think they do [listen to their peers]. From what my understanding is of what they're saying. *House master and Science Teacher NGB M*

> I think that they talk amongst themselves about what they are doing and compare what they are doing and maybe with their close friends see what they are doing. I would like to think that doesn't sway them but… I don't think that they talk to the older girls. I think that they talk to teachers. *Deputy Principal Curriculum GG M*

Two interviewees noted that subjects vary in popularity with the student body from year to year and this was believed to be related to comments and recommendations made by students who had studied the subject in prior years. One of these interviewees said that with respect to choosing Science:

> They'll often refer to older brothers or friends they know who have taken it and they will often go from peer recommendations. So they'll say 'Don't do bio, it's too much work, you have to learn too much stuff. *Science Teacher NGB F*

It was suggested by the Director of Senior School that the varying popularity of subjects was related to the teaching of the subject in prior years. She said:

> Subjects can go in and out of favour depending on the dynamism of the teacher. *Director of Senior School NGG[1] F*

The advice that students obtain from peers and siblings was seen as an issue by interviewees, mainly because of the potential for students to receive poor advice. One interviewee commented:

> They do make their informed decisions on information from previous years that may or may not be valid. *Head of Science NGG[2] F*

The views expressed by adults relating to the advice of peers are different from that voiced by students in the Focus Group Phase of the study. Adults stated that they were concerned that students followed the advice of their peers with respect to subject choice. Students stated they listened to the advice of peers and older siblings but did not generally follow such advice.

Some adults believed the influence of parents on their child's subject selection decision was very strong. The following three quotations exemplify this view:

> The expectations of their parents… is a big, big thing for us. *Deputy Principal/ Science Teacher GC M*

> For some it [choosing subjects] is very easy because their parents have a very strong influence over what they choose. Maybe as high as 10% is what I would think would be a strong influence. *Deputy Principal Curriculum GG M*

> And even parents will look at those honours lists and say 'oh wow, the dux didn't do a Science' or whatever. There is a lot of parental input, of course, in their decision making. *Head of Science NGG[2] F*

The impact of parents in the subject selection decision of their child was seen as being a negative factor for students in some instances. For example one said:

> They [parents] do have a bit of pull. Yeah they do which is a little bit unfortunate because they are not leaving the kids to making their own decisions. *Careers Adviser NGB F*

Where there was conflict between the wishes of the child and parent, teachers consistently stated that they supported the students in their choice of subject, one adult stating:

> I'm in the middle of this big argument between the child and the parent and to be honest I'm on the child's side. *Deputy Principal/ Science Teacher GC M*

The rationale given by adults for this standpoint was the belief that students should make their own decisions about subject selection as the student would be undertaking the work. This is exemplified by the following comment:

> I can actually say to parents, "well, it's actually not about you, you are not the one who is going to be sitting at a desk studying this subject". *Director of Senior School NGG[1] F*

A further concern is that, with respect to Science, "Parents often don't know themselves about what is available" (*Science Teacher NGB F)*.

The influence of parents may be related to nature of the relationship between the student and parent. Students in the Focus Group Phase stated that they listened to parental advice in general terms but did not listen to specific advice about which individual subjects to choose.

This section presented the findings from interviews held with the adult stakeholders within schools who helped students choose their subjects for Years 11 and 12. These interviewees said that enjoyment and interest in a subject were the most important factors that students should consider in choosing subjects. They also commented on the importance of choosing subjects that would enable students to obtain good marks for their ATAR. Teaching of subjects was considered an important factor in students' assessment of subjects for selection. Science was seen as a difficult subject relative to other subjects and one that was required for a narrow range of occupations.

The adults believed students received advice from several sources: Career Advisers, teachers, parents, peers, and siblings. Only some of this guidance was listened to and adults indicated the opinions of peers and siblings were considered more highly.

5.4 Summary

This chapter describes the key findings from the Environment Phase of the Fresh Minds study. It addressing the research question: What information are students provided with to assist them in choosing their subjects for Years 11 and 12 at school and how is this information assessed by them?

In the Environment Phase, seven subject selection events were observed at four schools and all the documents given to students at these events were reviewed. Semi-structured interviews were held with 15 adults within these schools who were identified by school representatives as being in a position to influence student subject choice.

Students attending subject information events were given comprehensive information describing the subjects they could choose for their final Years of school. Presenters advised students to choose subjects for which they had ability, interest and motivation, and would need for a future career or study path. Students were given the opportunity to ask questions at these events and asked Science teachers whether or not they were capable of undertaking Science and which Science subject they should study. Student asking these questions appeared to be choosing between Science subjects, not deciding whether they should study Science.

The written information schools provided to students was designed primarily to explain what they would learn if they chose a subject and the assessment requirements of that subject. Some of this literature defined the skills that students would obtain from studying Science. However, from the students' perspective these skills were not linked to the benefits of Science study in a range of careers beyond a conventional scientific career nor to the importance of scientific literacy to life generally. Comments made about Science in presentations at subject selection events reinforced the notion that Science is only useful for students considering traditional scientific-based careers such as engineering or medicine.

Interviews with the adults who were involved in advising students on subject selection revealed that while students receive a range of advice, they are usually advised to

take subjects they enjoy and in which they perform well. These adults believed students were not only strongly influenced by both teaching experiences and teaching expectations for Years 11 and 12. Students were also believed to be concerned with maximising their ATAR to allow university entrance. This data supports similar information revealed in the focus groups.

Adults interviewed shared the Focus Group students' broad views that Science is more difficult than other subjects. These adults also believed Science was very intense, content laden, and conceptually difficult. They remarked that students believed Science was difficult and such a view was justified. Adults at all schools noted that students have a narrow perception of where Science study may lead them.

The adult interviews revealed that a range of individuals provided advice to students about subject selection. The adults had varying views about whether students followed their advice but generally though that students listened to the advice of their peers and older siblings.

Chapter 6 will describe the Fresh Minds survey that was used to further investigate students' choice of subject. This survey contained a Best Worst Scaling experiment that utilised the attributes identified in the Focus Group Phase of Fresh Minds to investigate how students perceive and rank these attributes in their subject selection process.

CHAPTER 6: **Survey Phase**

6.1 Introduction

This chapter reports on the findings of the Survey Phase of the Fresh Minds study. Analysis in the Focus Group Phase (Chapter 4) suggests that students choose their subjects in a structured and staged manner. Participating students commonly reported that they found choosing subjects to be an important and difficult activity. They also stated that they felt well informed and that they chose the subjects they enjoyed and believed would find useful for further study or in a career after school. In the Environment Phase (Chapter 5), analysis of the information students received and the interviews with adults within participating schools revealed that students received comprehensive subject choice information and were generally advised to choose subjects that they enjoyed and in which they performed well.

This chapter presents the results of a survey that contained multiple-choice, interval-scale and free-response questions and a one of two randomly allocated Best Worst Scaling (BWS) components. The multiple-choice questions collected demographic data. The interval-scale and free-response questions examined student career plans, perceptions of choice difficulty and intentions apropos choosing Science. The BWS component investigated the subject choices made by students by quantifying the relative importance of the factors that Year 10 students consider in their subject choice decision making. The 21 decision-making factors were developed from the findings of the first two phases of Fresh Minds in association with results from similar studies presented in the literature review. The survey also provided an opportunity for students to give advice to the Researcher on how to increase enrolments in Science.

The Survey Phase of this investigation addressed the following research questions:

- What factors do students consider when choosing their subjects for Years 11 and 12 at school?
- What is the relative importance of the factors that students consider in choosing their subjects for Years 11 and 12 at school?

The remainder of this chapter is presented in four sections. Section 6.2 provides a description of the sample of students completing each part of the Fresh Minds survey. Section 6.3 describes results from the interval-scale and free-response questions. Section 6.4 describes findings from the BWS-Accept and BWS-Reject survey components. Section 6.5 discusses the survey results in the light of the Fresh Minds research questions and theoretical framework for this study. The survey used in the Fresh Minds study is presented in Appendix C.

6.2 Sample statistics

This section describes the sample of students who completed the Fresh Minds survey and information regarding the completion of each part of the survey.

6.2.1 **Participants**

A total of 386 students opened the online survey and 379 students (98%) agreed with the disclosure statement and commenced the survey. Table 13 shows the number of students who completed each part of the survey. Of the students who commenced the survey, 99% completed the demographic data and the first section comprising the multiple-choice, free-response and interval-scale questions. Eighty-eight percent of students then finished all sections of the BWS survey and stated whether or not they had chosen a Science. The survey presented to the students was lengthy, nevertheless the majority of students persisted with it. Students were logged on to the survey, for a median time of 13 minutes (range: 3 minutes to 2 days 3 hours).

Table 13: Number of students completing each part of the Fresh Minds survey

Survey part	BWS-Accept	BWS-Reject	Total	% of Total
Commenced survey	179	204	379	100
Multiple-choice questions	178	201	378	100
Choice career or study plan surety	177	201	378	100
Study/career plans*	124	154	366	97
Difficulty of choice	177	200	377	99
Completed BWS	**157**	**176**	**333**	**88**
Choice of Science	157	175	332	84
Science(s) chosen (if chosen)	147	172	319	84
Anything important missing*	79	101	180	47
Suggestions to encourage Science*	109	114	223	59

*indicates free-response question

The sample size calculated to be a representative sample of the Year 10 student population in NSW was 383 (see Section 3.2.5). Although the sample for the Fresh Minds Survey was close to this number, the schools selected are a convenience sample. Hence, the student sample is not representative of students in NSW.

Of the 379 students who participated in the survey, 55% were boys and 45% were girls. Thirty-one percent of the sample was aged 15 years and 57% of the sample was aged 16 years. Students from all five schools completed the survey, with 84% of these students attending non-government schools and 14% of students attending government schools. The sample is therefore strongly bias toward non-government schools. Table 14 shows the educational sector distribution of the respondents to the survey.

Table 14: Educational sector of survey respondents

School type	Number of respondents	Percentage of respondents
Government girls' school	34	9
Government co-educational school	19	5
Non-government girls' school	124	33
Non-government boys' school	196	52
Not specified	6	2
Total 5 schools	379	100

6.2.2 **BWS sample statistics**

The BWS-Accept and BWS-Reject versions of the survey were allocated randomly to respondents by the survey software. In total, 333 students completed the BWS survey with 157 (47%) students completing the BWS-Accept version of the survey and 176 (53%) completing the BWS-Reject component of the survey.

The sample distribution for the BWS-Accept and BWS-Reject survey versions is shown in Table 15. This table is based on demographics from the 333 students who commenced the BWS component of the survey.

Table 15: Number and percentage of respondents to the BWS survey component by gender and school sector

	BWS-Accept		BWS-Reject	
Students	Number	Percent	Number	Percent
Boys	93	59	89	51
Girls	64	41	87	49
Total	157	100	176	100
Government schools	22	14	24	14
Non-government schools	135	86	152	86
Total	157	100	176	100

6.3 Interval-scale and free-response questions

This section presents responses to interval-scale and free-response questions in the Fresh Minds survey. These responses are presented in four sections. Section 6.3.1 describes responses to the questions directed at determining students' surety about their future career or study plans. Section 6.3.2 reports the responses to questions about students' perceptions of the difficulty of the subject choice decision. This section compares results from questions addressing the difficulty of the subject choice decision-making process with results on the level of surety students felt about their career or plans after school. Section 6.3.3 provides data on students' choice of Science for future study and their rationale for this choice. Section 6.3.4 summarises responses to the two free-response questions. These questions asked students for advice on anything important missing from the survey that helped them to choose their subjects, and how to encourage more students to study Science.

6.3.1 **Future study or career decision status**

Students were asked about the surety of their decision making with respect to their future career or study plans. The question, "How sure are you about what you will study or choose as a career after you leave school" was answered by 378 students. The distribution of responses by male and female respondents was similar, as shown in Figure 6.1. The number above each bar is this chart in the number of responses represented by that bar. In total there were of 211 male respondents and 167 female respondents.

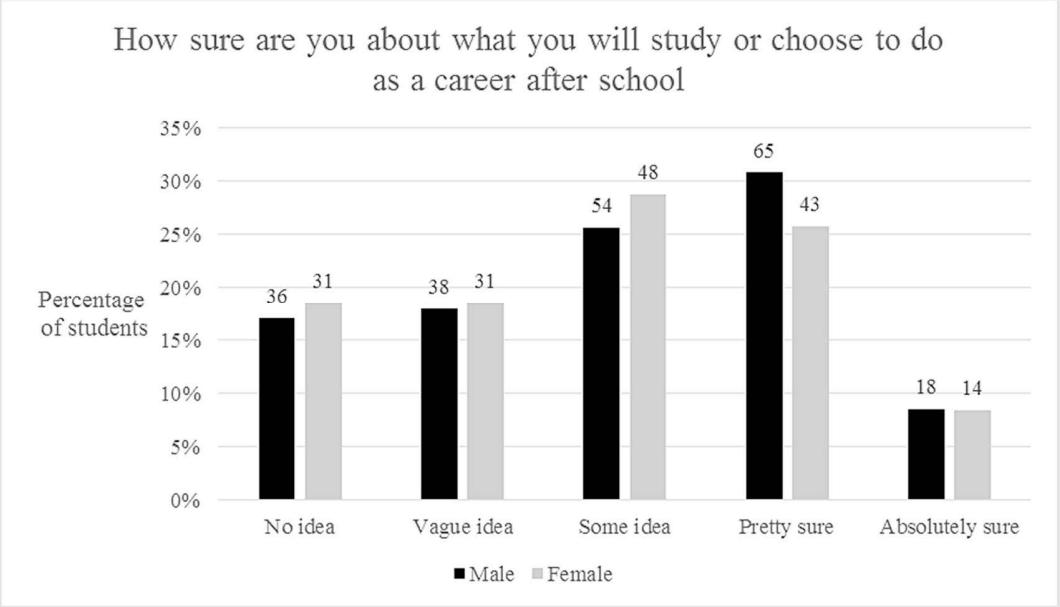

Figure 6.1: Percentage and number of male and female responses to 'How sure are you about what you will study or choose as a career after you leave school?'

The responses to the question on career path surety were broadly distributed with few students (n = 32, 8%) stating they were absolutely sure of their future career path. Thirty-seven percent of students (n = 140) indicated they were “pretty sure” or “absolutely sure” of what they will study or choose as a career when they leave school. Thirty-six percent of students (n = 136) indicated they had “no idea” or a “vague idea” when asked this question and 27% (n = 102) chose “some idea”.

Students were asked, “If you have an idea what you will do after school, please let me know what you have planned”. Of the 269 students who responded, five provided comedic answers (e.g., wizard). The remaining students described their plans in varying levels of specificity from “travelling” or “uni” to details of study intentions such as identifying a field of interest, “global politics and international relations”, or a specific career plan, “Do a Bachelor of Medicine & a Bachelor of Surgery and go on to pursue a career in Medicine (specialty of Emergency Medicine).”

Almost a third of students (32%) who stated that they were “pretty sure” or “absolutely sure” about what they would study after school indicated they had chosen a STEM-based career or course of study. Eleven students who had stated that they were “pretty sure” or, “absolutely sure” of their career plans did not provide details of these plans.

Sixty-four percent of the 378 students responding to the question about their level of career indecision had at least some idea about what they would study or choose as a career after school. This is a greater proportion than would be expected after analysis of comments by students in the Focus Group Phase. Three students in the focus groups (6%) stated that they had an idea of their intended career path and this figure is similar to the proportion of survey respondents who stated that they were “absolutely sure” of their career path (8%). The difference between the focus group and survey results is in the increased proportion of students from the survey who stated that they were reasonably sure of their intentions. This suggests that focus group participants may only have been willing to state their intention if they were very confident of their path or that students had developed clearer career plans in the period between the focus groups and survey.

Teachers and administrators interviewed in the Environment Phase stated that they thought that most students did not have a clear idea of their future career paths which contrasted to the view of Careers Advisers who estimated that 70-90% of students had an idea of their future plans. Students participating in this survey provided responses that indicate their actual level of surety with respect to their career and study decision making is between the two extremes expressed by adults at their schools.

6.3.2 **Subject choice decision making difficulty**

Students generally found that information about subjects was not difficult to find, with 52% of students stating it was “very easy” or “easy” to find information about subjects. A small percentage (13%) of students said they found it “very difficult” or “difficult” to find information, with the remaining 35% giving a neutral response to this question. Figure 6.2 shows the percentage of students responding to each option within the question: How difficult was it to find out information about the subjects? The number above each bar in

this chart is the number of responses represented by that bar. There were 210 male respondents and 168 female respondents to this question.

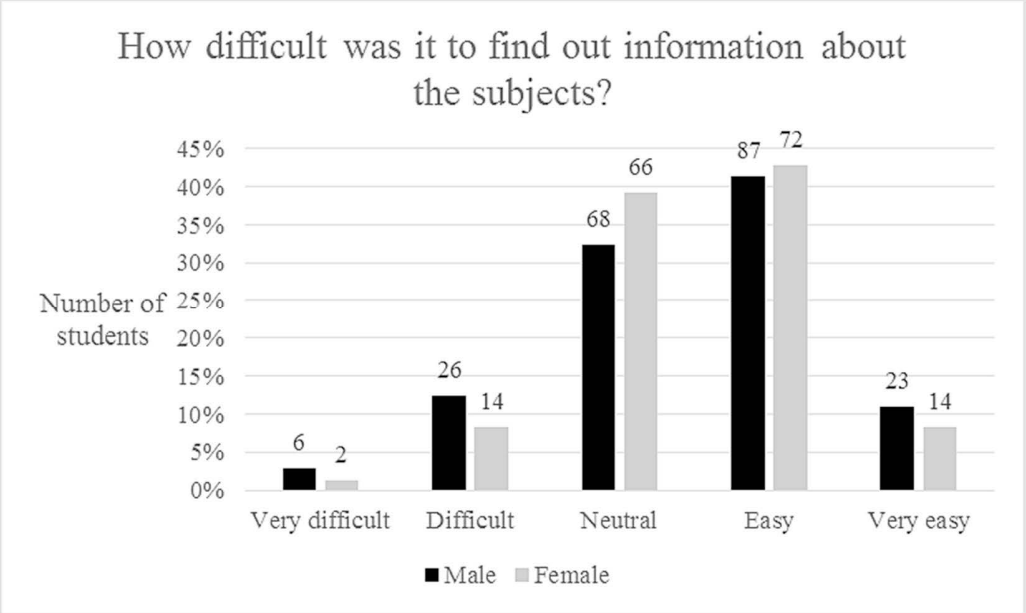

Figure 6.2: Percentage and number of male and female responses to, "How difficult was it to find out information about the subjects?"

Students in the Fresh Minds focus groups reported being satisfied with the information they were given by their school to help them make their subject selection decision. These survey responses indicate that some students found it difficult to find information about the subjects they could choose for further study.

The following three figures present data relating to relevant student perceptions of the difficulty of their subject selection decision. The number above each bar in these charts is the number of responses represented by that bar. Figure 6.3 shows responses to: How difficult was it to make your final subject selection. There were 211 male respondents and 168 female respondents to this question. Figure 6.4 shows responses to: How difficult was

it to choose subjects you wanted to do. There were 210 male respondents and 168 female respondents to this question. Figure 6.5 shows responses to: How difficult was it to choose subjects you did not want to do? There were 210 male respondents and 167 female respondents to this question.

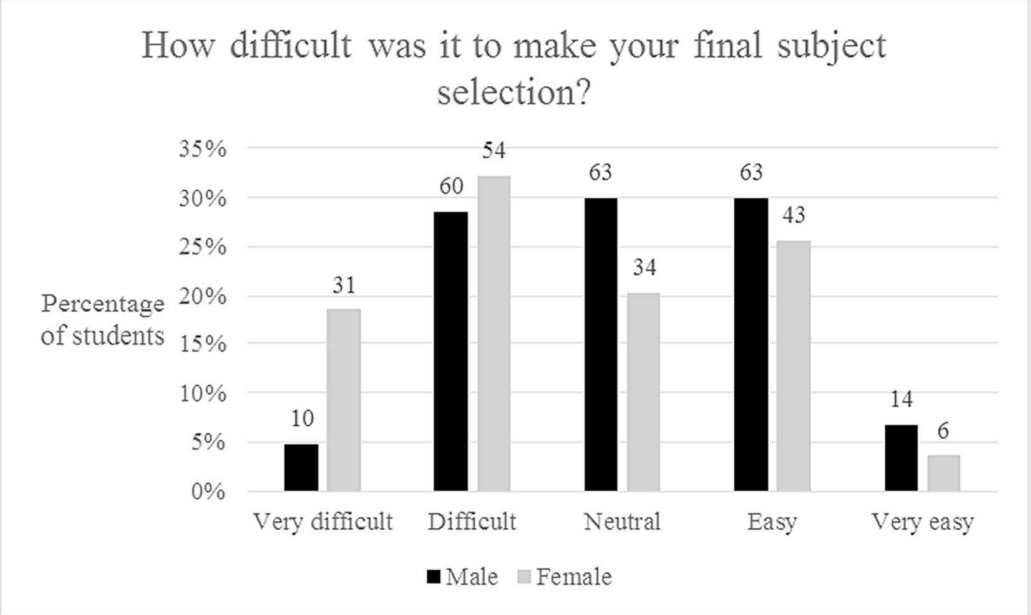

Figure 6.3: Percentage and number of male and female responses to, “How difficult was it to make your final subject selection?”

Figures 6.4 and 6.5 show that students varied in their responses to how difficult they found the subject selection decision and that there is a difference in the perception of difficulty depending on whether students are considering which subjects to choose or reject.

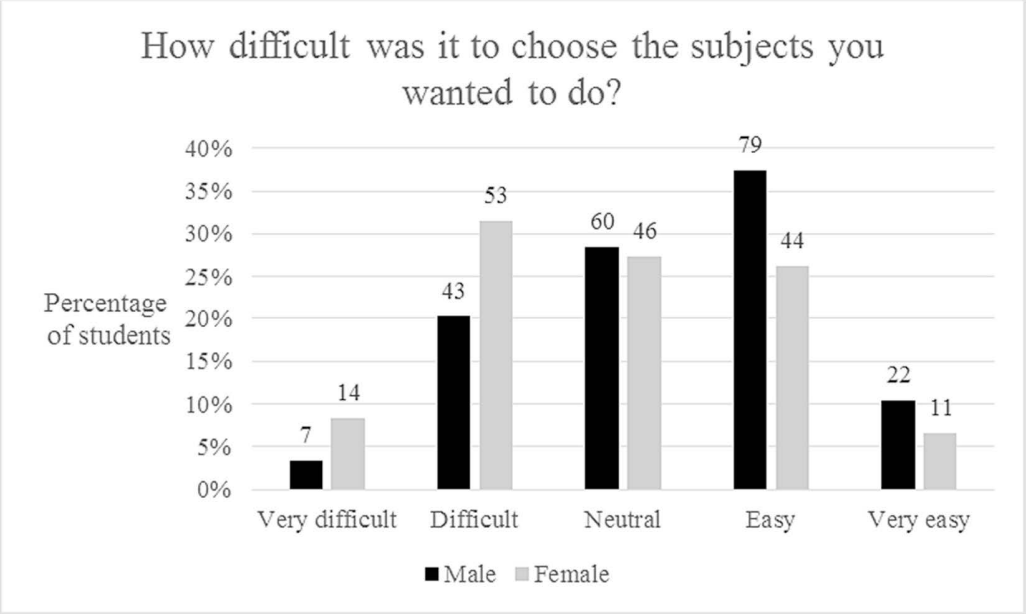

Figure 6.4: Percentage and number of male and female responses to, "How difficult was it to choose the subject you wanted to do?"

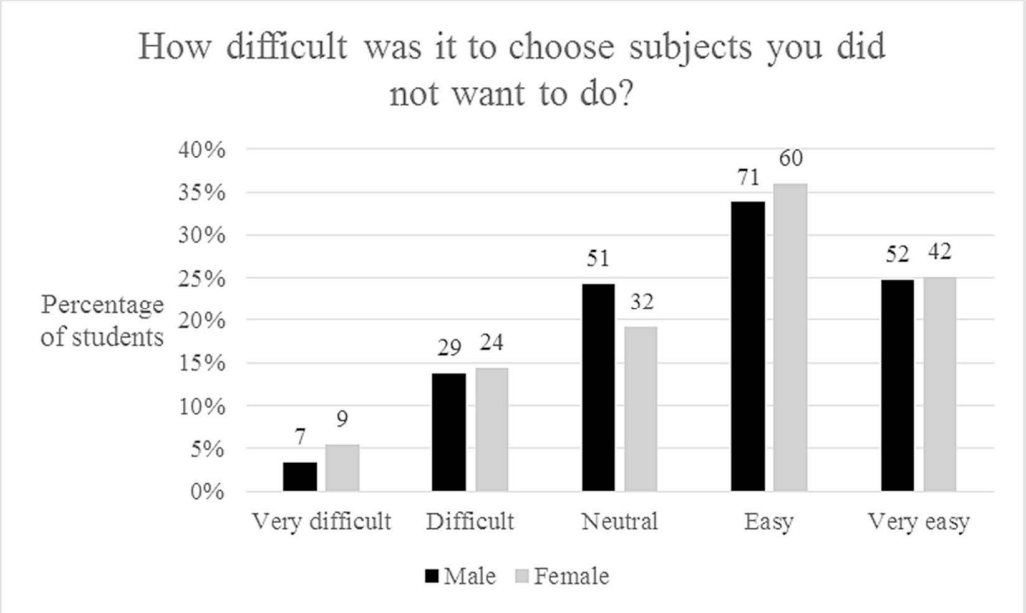

Figure 6.5: Percentage and number of male and female responses to, "How difficult was it to choose the subjects you did not want to do?"

In order to understand the differences between student responses to the interval-scale questions regarding the difficulty of subject choice, descriptive and inferential statistical analysis were conducted. Pearson Correlation Coefficients ("correlations") denoted as (*r*), student *t*-tests (t) and *p* values (*p*) were calculated. To calculate these statistics, these data were treated as interval data (see methodology section 3.5.2). For the question "How sure are you about what you will study or choose as a career after you leave school?" the answer "no idea" was given a score of 1, "vague idea" was scored 2, "some idea" was scored 3, "pretty sure" was scored 4 and "absolutely sure" was given a score of 5. For the four questions concerning the difficulty of choosing subjects, "very difficult" was given a score of 1, "difficult" was scored as 2, "neutral" was scored as 3, and "very easy" was scored as 5. The mean score, standard deviation, standard error and sample size for each factor presented in these figures is shown in Table 16 and Table 17. These tables display correlations and notes statistically significant *p* values resulting from *t*-tests comparing the responses for each question verses every other question regarding difficulty of subject selection.

Table 16: Descriptive statistics for difficulty of subject selection choice survey questions

	How sure are you about what you will study or choose as a career after you leave school?	How difficult was it to choose the subjects you wanted to do?	How difficult was it to choose subjects you did not want to do?	How difficult was it to find out information about the subjects?	How difficult was it to make your final subject selection?
Mean (M)	2.92	3.13	3.62	3.47	2.87
Standard Deviation (*SD*)	1.23	1.06	1.13	0.89	1.10
Standard Error (*SE*)	0.06	0.05	0.06	0.05	0.06
Sample size (n)	378	379	377	378	378

The correlation (r) between student answers for the decision-making questions were determined and significance tests using paired t-tests were performed on the responses to each question compared to the other questions. The null hypothesis is that there is no correlation between the answers to the interval scale questions. The resulting analysis is presented in Table 17.

Table 17: Correlations between responses to difficulty of subject selection choice survey questions

Questions	How sure are you about what you will study or choose as a career after you leave school?	How difficult was it to choose the subjects you wanted to do?	How difficult was it to choose subjects you did not want to do?	How difficult was it to find out information about the subjects?	How difficult was it to make your final subject selection?
How sure are you about what you will study or choose as a career after you leave school?	1.00	.20***	.02	.04	.13**
How difficult was it to choose the subjects you wanted to do?	-	1.00	.11*	.31***	.60***
How difficult was it to choose subjects you did not want to do?	-	-	1.00	.11*	.14**
How difficult was it to find out information about the subjects?	-	-	-	1.00	.39***
How difficult was it to make your final subject selection?	-	-	-	-	1.00

* $p < .05$, ** $p < .01$, *** $p < .001$

Within Table 17, both the statistically significant differences and non-significant differences in correlation between the questions on difficulty of choice are of interest. "How sure are you about what you will study or choose as a career after you leave school?" was correlated ($r = .20$, $t(376) = 3.94$, $p < .001$) with "How difficult was it to choose the subjects you wanted to do?" and correlated ($r = .13$, $t(377) = 2.46$, $p = .014$) with "How difficult was it to make your final subject selection?" This suggests that students who are

more certain of their career path found it easier to choose the subjects they wanted to study, but there is some indication that they still found some difficulty making the final subject selection decision.

There was no correlation between the surety of a student's career or study plans and choosing subjects students did *not* want to study ($r = .02$, $t(376) = .35$, $p = .73$) or had difficulty in finding information about subjects ($r = .04$, $t(377) = .79$, $p = .43$). These results indicate that knowledge of a career path may not make it easier for students to decide which subjects to reject. Surety of career path did not appear to be related to a student's ability to find information about subjects they could choose.

There are statistically significant correlations between "How difficult was it to choose the subjects you wanted to do?" and both "How difficult was it to find out information about the subjects?" ($r = .31$, $t(378) = 6.22$, $p < .001$) and "How difficult was it to make your final subject selection?" ($r = .60$, $t(376) = 14.6$, $p < .001$). Difficulty in finding information about subjects was also correlated with the difficulty in making a final subject choice ($r = .39$, $t(376) = 8.27$, $p < .001$). As expected, this indicates that students find choosing subjects and making their final subject choice are closely related and that finding information to make this choice is an important factor is assessing difficulty of the decisions.

There was a statistically significant correlation between the student responses on the difficulty in choosing subjects they did, and did not, want to study ($r = .11$, $t(377) = 2.21$, $p = .03$). Choosing subjects students did not want with do was also correlated with finding information about subjects ($r = .11$, $t(377) = 2.11$, $p = .04$) and to the difficulty students found in making a final subject selection; ($r = .14$, $t(375) = 2.74$, $p = .007$). Taking into consideration the low level of statistical significance between some of these questions, these findings adds support for the notion that students approach choosing and rejecting subjects differently.

6.3.3 **Choice of Science**

In total, 332 students answered the question, "Did you choose to study Science for Year 11?" of these, 211 (64%) stated that they had chosen a Science and 121 (36%) stated that they had not chosen a Science. Students were requested to provide a rationale for their choice and this is discussed later in this section. Of the students who stated that they had chosen a Science, 54% were male and 46% were female. For those who did not choose Science, 57% were male and 43% were female. The gender mix is similar to that of the overall sample of students completing this question (55% male, 45% female) indicating there is no strong gender bias for students who had chosen a Science subject or not.

Subjects studied

Student respondents were asked to provide information on their choice of Science subject. The percentages of the total number of students who chose individual Science subjects is shown in Table 18.

Table 18: Percentage of students choosing Science subjects

	Subject						
	Biology	Chemistry	Physics	Senior Science	Earth & Environ.	Other	Total students
Students	29%	33%	19%	1%	1%	1%	332

The gender distribution amongst the students who chose science is shown in Table 19. The table shows the percentage of male and female students who selected particular Science subjects. Taking into account that the gender mix of the students who chose a Science was 54% male and 46% female, Physics was selected by 62% of boys and 38% of girls. Senior Science and Earth and Environmental Science (Earth & Environ.) was indicated as a choice by too few students to draw any conclusions based on gender. Fifty-eight percent of girls

and 42% of boys stated that they had chosen Chemistry. Biology was chosen by similar proportions of boys (51%) and girls (49%).

Table 19: Science subjects chosen by male and female students who chose a Science subject

	Subject						
	Biology	Chemistry	Physics	Senior Science	Earth & Environ.	Other	Subject Total
Male	38%	27%	27%	3%	1%	3%	146
Female	38%	38%	17%	1%	3%	3%	144
Both	39%	33%	22%	2%	2%	3%	290
Total students per subject	112	95	63	6	6	8	

In total, 290 Science subjects were chosen by the 179 students who answered the question about Science subject choice. Four students indicated they were taking more than the maximum of three Science subjects and had provided other unusual responses to free-response questions. Their data were deleted from the sample because the data from these students was not considered reliable. Of the resulting students indicating that they had chosen to study Science, the mean number of Science subjects undertaken per student was 1.6. The number of subjects taken by students is shown in Table 20. Boys and girls show a similar pattern in the number of Sciences chosen.

Table 20: Percentage of male and female students taking 1, 2 or 3 Science subjects

	Number of sciences			Number of students
	1	2	3	
Male	54%	39%	7%	90
Female	52%	39%	9%	85
Both	53%	39%	8%	175

Comparison with subject choice data provided by schools

After these students' subject selections were made, the participating schools were also asked to provide Science subject choice data for the Year 10 students in their schools. This data allowed comparison of the intentions of students with their behaviour towards Science subject choice. Enrolment numbers in each Science were provided by four of the five schools. Two of these schools also provided data on the number of students studying two or more Sciences. Year sizes for the relevant year groups were obtained from the government website www.myschool.com.au. Table 21 shows the proportion of male and female students that schools reported had chosen the indicated Science subjects. The trends are similar to those evident in the survey results as shown in Table 19: Physics and Senior Science were selected by more boys than girls and Earth and Environmental Science (Earth & Environ.) was selected by more girls than boys. Although similar numbers of girls and boys indicated they would study Biology in the survey, the proportion of females studying Biology was higher than that of males.

Table 21: Percentage of students choosing Science subjects as reported by participating schools

	Subject					
	Biology	Chemistry	Physics	Senior Science	Earth & Environ.	Total Subjects
Male	24%	22%	30%	6%	0%	415
Female	33%	22%	21%	0%	6%	253
Total students	196	148	161	14	23	

In total, 544 Science subjects were chosen by the 668 students at the four responding schools. This means that students at the four schools who provided data studied an average of 0.83 Science subjects per student. In the Fresh Minds survey, 332 students responded to the question, "Did you choose to study Science for Year 11?" and these students chose a total of 290 Science subjects, resulting in an average of 0.87 Science subjects studied per

student. These averages are similar and suggest the information students provided in the survey reflected their actual subject choices with respect to Science.

Reasons for choice

Of the 332 students who answered the question about whether they had chosen a Science subject for study, 312 provided a response to the free-response question asking why the student did nor did not choose Science. Fifty-nine percent provided an explanation of why they chose Science and 41% explained why they did not.

The comments made by students were coded into themes and the results of this analysis are presented in the following sections.

Choosing Science

As displayed in Table 22, students gave multiple reasons for studying Science. The table shows the number of comments made by students within each theme and the percentages of students who provided an explanation for choosing Science. Some students made comments related to multiple themes.

Table 22: Student reasons for choosing to study Science

Comments	Interest	Enjoyment	Ability	Study or career	Teacher advice	Past Teaching	Need units
Number	54	69	51	80	2	2	5
% students	29%	38%	28%	43%	1%	1%	3%

The most common reason cited for choosing Science (43% of students) was a belief that they would need Science for future study or career as illustrated by the following quotes:

> Because it will be necessary to do most engineering courses at university.

> Because I greatly enjoy Science as it is one of my best subjects and I would need it for my aimed areas of tertiary study.
>
> Because Science is has always fascinated me and suits my future ambitions.

Students also frequently commented that they chose Science because they found it interesting and/or believed they could achieve good marks in the subject:

> Because I find physics interesting and I got pretty good marks in it this year.

A small number of students commented that they had chosen the subject on the advice of a teacher, been encouraged by past good teaching, or needed the subject to make up their required number of units.

Of the 184 students providing a reason for choosing Science, 101 students (55%) cited a single reason. The most common reason given by these students was the need for Science for future study or a career (64 students (35%) of all single responses). One quarter (24 students) commented that the single reason was an interest in Science and 14 students (15%) stated it was enjoyment of the subject. One student stated that she chose biology because of, "a really good class teacher" in the previous year. Four students stated that they chose Science because they needed extra units.

Several student wrote extended responses, for example:

> Because I am interested in chemistry, I feel it may open up doors in the future, I enjoy being able to understand the way things run in the world (why things happen and how to fix them as well), I enjoy being challenged (to an extent), I feel that scientific understanding and knowledge is important for a community.
>
> Because Science has always interested me and I am looking for a career in law enforcement. I want to do a Forensics degree and Biology and Chemistry are pre-requisites for the course. I also really enjoy them even though I am not very good.

Not choosing Science

Students gave reasons for not choosing Science within seven themes that are similar (but opposing) to those for students who chose Science. These themes, the frequency of

comments made within each theme, and percentage of students making a comment on a particular theme are displayed in Table 23. Some students made comments related to multiple themes.

Table 23: Student reasons for not choosing to study Science

Comments	No interest	Not like/ enjoy	Low Aptitude	Not needed	Poor teaching	No units	Not suited	Advice
Number	30	49	42	21	17	8	7	1
% students	23%	38%	33%	16%	13%	6%	5%	1%

The major reason students stated for not choosing Science was that they did not enjoy the subject and/or they found the subject difficult. One student stating:

> I struggle to understand the subject and I don't enjoy it at all.

Some students expressed strong feelings with respect to Science. For example, students stated that they did not choose a Science, “Because I hate it”.

Not having an interest in Science was cited as a reason by 23% of students. For example two students stated:

> Science does not interest me in the slightest and I will not succeed in a subject if I am not interested.

> Because I find it boring and I believe there are more important things that should be studied such as economics.

A third of students (33%) stated they had not chosen a Science because they found Science challenging, or they expressed concern that they would not be able to obtain good marks in the subject. For example:

> Science is one of my weakest subjects and I find it very challenging.
>
> I find Science difficult to comprehend, therefore I do not enjoy it.

The lack of need for the Science in the student's future career or study plans was cited as a reason for not choosing Science by 16% of these students. A further 5% made general comments that they felt they were not suited to Science. For example:

> Because I don't want to be a scientist in the future or need Science for what I plan to do.
>
> Cause Science isn't my thing, and it juxtaposed my inspirations for the future.
>
> The subjects did not interest me. I also had no plan to study Science at university or a career.

Previous poor teaching experiences were stated as a contributing factor in not choosing Science by 13% of the students. Comments included:

> I really really dislike Science and I've had a very irritating teacher 2 years in a row, completely turning me off the subject
>
> The reason I didn't choose Science as a subject next year was because of my teacher. Subject selections really depends on the type of teacher you have. This year my teacher for Science was very tedious, showed no emotion and didn't have the desperation like other teachers to help benefit the student.

A single reason for not choosing Science was stated by 121 students (65%). The three most common sole reasons for not choosing Science are: that students did not enjoy or like the subject (26%), they found it too hard or confusing (21%), and that Science was boring (21%). No need for a career and not requiring the units are each cited as a single reason by 7% of students and teaching factors by 4% of students. One student commented that he had not chosen Science on the advice of a teacher.

The next section discusses the comments made by students in the final two free-response questions of the Fresh Minds survey.

6.3.4 **Advice from respondents**

Students were provided with two optional free-response fields at the conclusion of the survey to give responses to the questions, “If there is anything important that helped you choose your subjects that hasn't been mentioned in this survey, can you tell me about it here?” and “Do you have some advice for me on how to encourage more students to study Science for Year 11?”

Additional factors in subject choice

A total of 180 students (47% of sample) provided a response to the question asking what factors were missing from the questionnaire. The majority of responses (172) either stated that there were no missing factors or reiterated factors present within the survey. Table 24 shows comments from the remaining eight students who provided responses on missing factors.

Table 24: Student comments on factors missing from survey

Topic	Comments
Relationships	My interests in Agricultural practises and my Girlfriend and what we plan to do after school.
	What students are in a class.
Faith	God.
Available subjects	I had the subjects that I would love to do but none of them were offered in this school which I did not get any opportunity to chose
Feedback	I think the surveyed pretty much covered it all, but there is also one factor: which subject provides good feedback? Some subjects don't even explain to you what is right or wrong or what you could improve (i.e. English sometimes) and that gives you uncertainty about your future performance on the subject. I don't know if it is the teachers' fault or whatsoever, but if I received a concise and clear feedback from a subject assessment like Science, I would prefer to choose that subject because I know what I did wrong and what I can improve on.
Support	I also feel having the support for the subject is important as if the subject is seen as too hard or easy it may be avoided
Complementary subjects	Subjects which complement each other.
	Subjects that will work well together e.g. Languages.

The comments on relationships, faith and availability of subjects are beyond the scope of this study. The comments regarding feedback, the requirement for support, and the suggestion that subjects complement each other require further investigation to determine if these are factors that are more widely considered by students in their subject choice decision.

Ways to encourage Science study

A total of 223 students provided a response to the question "Do you have some advice for me on how to encourage more students to study Science for Year 11?" Forty-nine of these students responded with, "n/a", "no" or a similar comment, resulting in 174 students providing advice.

As shown in Table 25, the responses are related to eight main themes. The table shows the number of comments made by students who provided advice within each theme and the percentages of these students who made a comment within the theme. Some students made comments that related to multiple themes.

Table 25: Survey responses - advice from students on ways to encourage Science study

Comments	More interesting	More enjoyable	Less difficult	Explain use	Improve teaching	Better information	Do not encourage
Number	33	29	11	39	19	12	19
% students	19%	17%	6%	22%	11%	7%	11%

Interest and enjoyment. Approximately one third of students (34%) made comments that suggested making Science more interesting and/or enjoyable in earlier years at school would encourage more students to take Science in Years 11 and 12. Similar numbers of comments were made with respect to making the subject interesting (33 comments) or enjoyable (29 comments). Typically, comments are brief (3-5 words) stating that Science needs to be more, "fun", "interesting" or, "enjoyable".

Some students provided specific advice as to how Science could be changed to make it more interesting and enjoyable. These students frequently mentioned more practical lessons and relating classroom work to real life situations as being methods of achieving this. For example:

> Show cool, practical experiments to students and get them to think about a problem or situation.

One student offered a specific comment relating to pedagogical practices:

> Make the content in the junior years more interesting. Change practical tasks so that they actually asses knowledge and make teachers only teach the subject they know even in junior school. I.e. don't have a teacher who is a senior chemistry teach Year 10 biology. Teachers should be on a yearly rotation depending on the subject that is being taught at each time.

Difficulty. Reducing the difficulty of Science, or the perception of difficulty, was considered a factor in encouraging students to choose Science by 11 students (6%). These students advocated simplifying the content or suggested teaching the content in a more simplified manner. For example:

> Make the coursework look less confusing and simplify it.

> Maybe narrow down the amount of topics learnt in Year 10 so that people may learn more about their desired topics.

> Make it taught in a simpler way, so people understand it more.

> Less practical examinations. Do not just promote the subject for smarter students.

Usefulness of Science. Highlighting the usefulness to students of Science for a career or for life in general was stated by 39 (22%) respondents as a way to encourage more students to choose Science. The description of usefulness is exemplified in these quotes:

> Helping people in the future, further job opportunities, broadened general knowledge, widened understanding of the world.

> Tell them about how doing Science improves your range of options for university courses and careers.

> Explain what careers involve Science why these careers should be ones people should be interested

A student who did not choose Science suggested that the perception of the usefulness of Science may be limited as follows:

> Many people believe that you only have to take a Science if you want to go into medicine, and you could demonstrate how there are actually lots of different career options. There is also a preconceived idea that Science is extremely hard, so this could also discourage some students from studying a Science.

Another student commented on the information relating to Science careers in stating:

> Make sure it [Science] is well funded, people who don't know what to do are told how diverse biology and chemistry are and … [are] well paying jobs maybe?

Teaching. Improving teaching and support for students was suggested by 11% of students responding to this question. These students made general comments about improving teaching in earlier years. Some provided further explanation and suggestions for improvement. For example:

> Ensure its [Science is] taught better from a younger age.

> I have had some pretty consistently weak Science teachers over the last couple years. While this does not discourage me it may be the tipping point for some.

> Re-survey the teachers and bring in new people to replace teachers with ineffective teaching methods as they, in my opinion, don't get through to any of the students and the class becomes a waste of time and money

> [Provide] teachers that are more involved in the subject rather than writing on the whiteboard, then leaving the class to complete a worksheet or questions.

One student offered specific advice for students dealing with poor teaching as follows:

> Trust your teachers, even though some of them aren't good and can discourage you, if you like the subject you have to hope you get a good teacher, so you can excel.

Better information about Science in senior years. Twelve students (7%) commented that better knowledge of HSC Science subjects would have encouraged more students to choose a Science. Typically, these students stated the need for:

> Better information regarding Science related to providing better information about Science subjects in Years 11 and 12.

Two of these students made practical suggestions for how students may be better informed:

> Give students a better idea of what the Sciences in yr 11 and 12 include and the information that they will already need to know going into the subject. Give this information at the beginning of the year so that they have all the information going into the subject selections also so that they can apply themselves correctly in Year 10 to get ready for Year 11 and 12.

> Make it funner and more active for students in Yr 10 and 9 so they are looking forward to what they could get up to in the more senior Years. For example you could let them see some of the fun experiments that are done by the seniors in Yr 11/12.

Advice from students <u>not</u> to encourage Science choice. Nineteen respondents (11%) suggested that students should not be encouraged to choose Science. The most comprehensive comment on this topic was made by a student who had chosen a Science subject:

> You can't force or encourage students to study Science and get a positive result. Science used to be compulsory for the HSC, or chemistry was. However not many people would have engaged with the subject. Students view Science as a useless subject. You could potentially show students what Science has done and potentially change the syllabus to make it more engaging. However, I personally don't think that anyone can change the enrolment levels or Science. Like economics, you have to let the trend work itself. At the moment not many students are interested in Science. Nature always compensates is something that I have learnt. Because Nature is in patterns not random occurrences, I believe that the trends will pick up again towards the future.

Other students indicted to encourage more students to choose Science could be seen as coercion. For example:

> No, if someone likes Science they'll do it if they don't they won't, if you force a subject someone won't enjoy it and may not do well.

> You can't, this is Marxism.
>
> Stop trying to brainwash children who don't want to do Science into doing Science.
>
> It is a personal choice, I don't think you should make/encourage students to do a Science. Just like you shouldn't put pressure on students to do a History or Maths, you shouldn't put pressure on "encourage" students to do a Science.

These responses highlight the importance of informing students of choices but not creating a situation where they feel coerced into choosing Science.

Novel advice. Three students provided the following novel advice:

> This is really hard to say because everyone is different but just say to students, "best things in life resides in mystery.
>
> Give students a choice at the end of Year 8 what Science they want to study.
>
> Science Puns at the end of examinations - e.g. "My name is Bond - Covalent Bond."

6.3.5 **Summary of key findings**

The interval-scale sections of the Fresh Minds survey showed that, at the time subject choices were made, students varied greatly in their level of career indecision, with over a third indicating they had no idea or a vague idea of their future path. A strong positive correlation was found between a student's degree of career indecision and how difficult students found choosing the subjects they wanted to do. There was no similar relationship between career indecision and choosing subjects students did not want to do.

Students were varied in their assessment of the difficulty of subject selection. However, few students said they found the process very easy or very difficult. There was a correlation between the difficulty students found in finding information about subjects and choosing subjects. Students found it easier to identify subjects they did not want to study than those they did want to study.

Students provided reasons for choosing or not choosing Science. For those students who they had chosen a Science, the most common reasons were that they required the subject for future study or a career and that they enjoyed Science. Students also stated they had chosen a Science because they found Science interesting and had performed well in the subject. For those students who had not chosen Science, the main reasons they cited were that they did not enjoy Science and/or found it difficult.

Students were asked to identify factors that helped them choose subjects which were not covered in the survey. Six additional specific factors were mentioned by eight students, three of these require further investigation.

Students were asked to suggest ways to encourage more students to study Science. Common suggestions by students were that the usefulness of Science be made clear to students and that Science be made more interesting and enjoyable to study. Some students disagreed with the proposition that students should be encouraged to take Science.

The interval-scale sections and free-response questions of the survey revealed information relating to student views on career and subject selection. The next section presents the findings from the BWS component of the Fresh Minds survey.

6.4 Best Worst Scaling

The purpose of the BWS component of the survey was to quantify the relative importance of the factors for subject choice that were identified in the Focus Group Phase. As outlined in Chapter 3, BWS allows the relative importance of factors to be quantified by presenting factors in sets to respondents and asking them to choose the best and worst option from each set. The BWS task is less challenging for respondents than ranking a large list of items and is more informative than asking for the factors to be assessed individually.

This section describes the factors tested in the BWS survey and provides an overview of results of the BWS-Accept and BWS-Reject versions of the survey.

6.4.1 **Factors for BWS**

The list of factors generated from the Environment and Focus Group Phase*s* of Fresh Minds, in association with results from similar studies presented in the literature. These factors were generated by reviewing each node created in the analysis of the Focus Group Phase to determine the range of factors commonly considered by students in their subject choice deliberations. This list was reviewed to include the views adults expressed during the Environment Phase. For example, a factor relating to the influence of peers was included even though students did not believe this to be an important factor in their choice decision. The list was compared against factors identified in similar research conducted in Australia (Lyons & Quinn, 2010; Nolan, 2012; Warton & Cooney, 1997; Whiteley & Porter, 1999) to ensure that important factors identified in other research were not omitted.

Table 26 shows the list of factors produced. The table shows the question grouping, an identifying number given to each factor, the short title for each factor and the statement pairs relating to each factor that were used in the accept and reject version of the BWS survey.

Table 26: BWS-Accept and BWS-Reject subject selection attribute statement pairs

Grouping	Factor #	Factor title	Attribute statement for BWS-Accept	Attribute statement for BWS-Reject
Advice	1	Parent advice	My parent(s) suggested doing the subject	My parent(s) suggested not to do the subject
	2	Older peer advice	Older students or sibling suggested doing the subject	Older students or siblings suggested not to do the subject
	3	Peer advice	A friend in my year suggested doing the subject	A friend in my year suggested not doing subject
	4	Teacher advice	My teacher suggested doing the subject	My teacher suggested not to do the subject
Enjoyment and Interest	5	Interest expectation	I will find the subject interesting	I will find the subject boring
	6	Enjoyment experience	I enjoyed the subject (or similar subject) in middle school	I did not enjoy the subject (or similar subjects) in middle school
Logistics	7	Number of units	I needed extra units	I had too many units
	8	Timetable fit	The subject fitted with my timetable	The subject did not fit my timetable
	9	Information	I had plenty of information about the subject	I did not have enough information about the subject
Ability (marks)	10	Ability	I got good marks in the subject (or similar subject) in middle school	I got poor marks in the subject (or similar subject) in middle school
	11	ATAR scaling	The subject will scale well for my ATAR	The subject will not scale well for my ATAR
	12	Mark expectation	I think I can get good marks in the subject	I think it will be hard to get good marks in the subject
Subject character-istics	13	Assessment type	I like the type of assessment	I do not like the type of assessment
	14	Classwork style	I will enjoy the classwork for this subject	I won't enjoy the classwork for this subject
	15	Difficulty	I will find the subject easy	I will find the subject difficult
Teaching	16	Teacher quality	I think the subject's teachers can help me get a good mark	I don't think the subject's teachers can help me get a good mark
	17	Teaching style	I like how the subject is taught	I do not like how the subject is taught
	18	Teacher like/dislike	I like a teacher or teachers I might get	I dislike a teacher or teachers I might get
Usefulness	19	Need for future study	I probably need the subject for my future study	I probably do not need the subject for my future study
	20	Need for personal life	The subject will be useful in my personal life	The subject will not be useful for my personal life
	21	Need for career	The subject could be useful for my career	The subject is unlikely to be useful for my career

The Fresh Minds survey presented students with sets of these 21 factors that were phrased as the attribute statements shown in Table 26. These statements are expressed in pairs to reflect two different approaches to selecting subjects – accepting and rejecting. Students were presented with sets of either accept or reject attribute statements but not both. The attribute statements were arranged in a statistical design (see Section 3.5.2) such that each statement was presented five times in combination with four other statements. This resulted in the creation of 21 sets of five attribute statements for the accept attribute statements (BWS-Accept) and 21 sets of five attribute statements for the reject attribute statements (BWS-Reject). Students were randomly allocated either the BWS-Accept or the BWS-Reject component of the survey.

6.4.2 **BWS-Accept**

The BWS-Accept survey allowed the factors that students considered in choosing their subjects to be scored using BWS analysis and thus compared. See section 3.5.3 for a description of the scoring methodology. Figure 6.6 shows the BWS score for the 21 factors students considered when choosing which subjects to study in Year 11 at school. This figure shows the ranking of factors for choosing a subject from the most important at the top to the least important at the bottom. The data for this graph displayed in rank order is shown in Table 27.

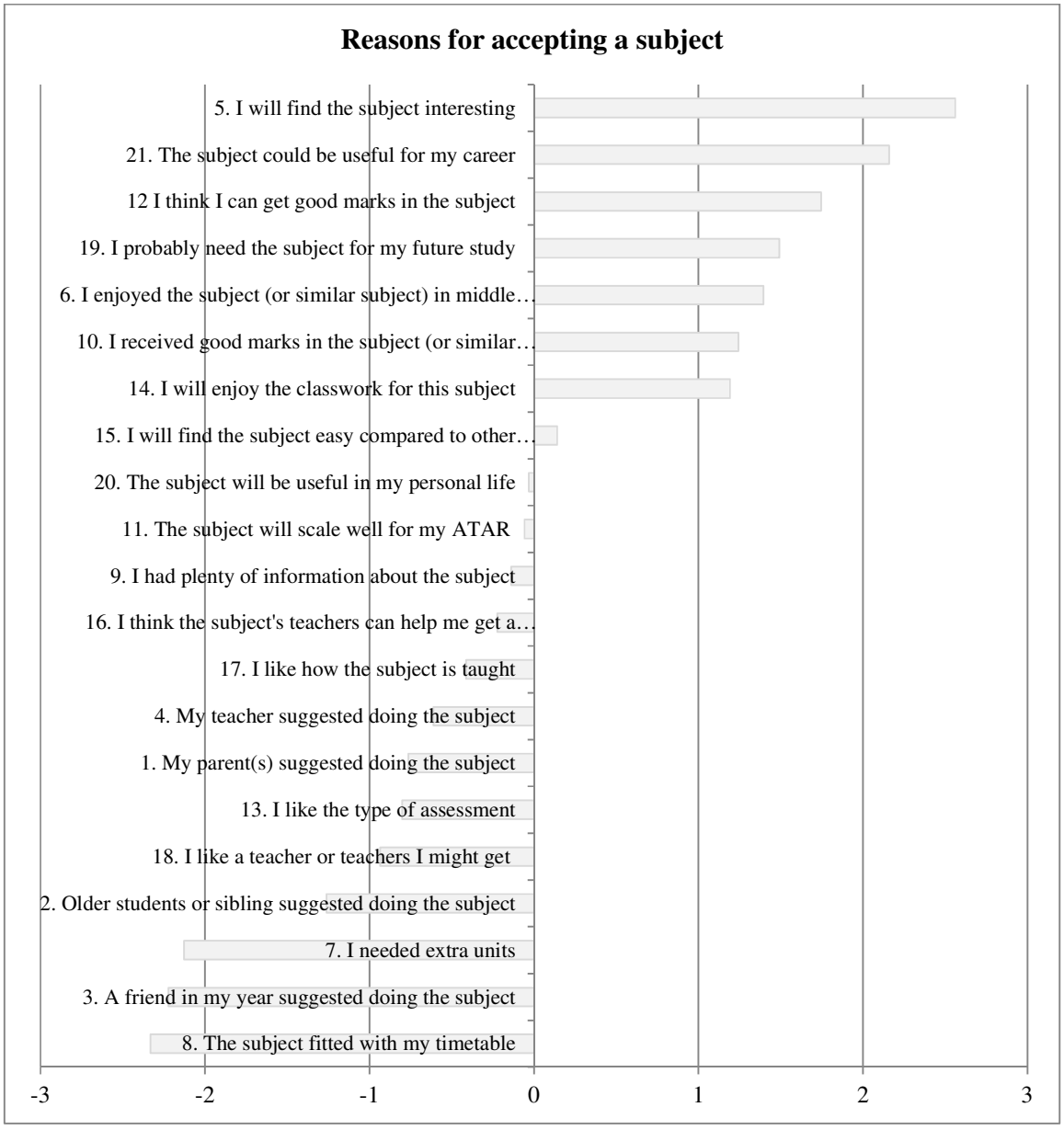

Figure 6.6: BWS-Accept: Reasons for choosing a subject.

Table 27: BWS-Accept reasons for choosing a subject - ranking and descriptive statistics

Rank	Factor number and title	Grouping	BWS Score		
			Mean (M)	Standard Deviation (SD)	Standard Error (*SE*)
1	5. Interest expectation	Enjoyment and interest	2.56	1.76	0.14
2	21. Need for career	Usefulness	2.16	2.04	0.16
3	12. Mark expectation	Ability (marks)	1.75	1.65	0.13
4	19. Need for future study	Usefulness	1.49	1.88	0.15
5	6. Enjoyment experience	Enjoyment and interest	1.39	1.63	0.13
6	10. Ability	Ability (marks)	1.24	1.65	0.13
7	14. Classwork style	Subject characteristics	1.19	1.74	0.14
8	15. Difficulty	Subject characteristics	0.14	1.73	0.14
9	20. Need for personal life	Usefulness	-0.03	2.02	0.16
10	11. ATAR scaling	Ability (marks)	-0.06	2.03	0.16
11	9. Information	Logistics	-0.14	1.37	0.11
12	16. Teacher quality	Teaching	-0.22	1.61	0.13
13	17. Teaching style	Teaching	-0.41	1.52	0.12
14	4. Teacher advice	Advice	-0.61	1.50	0.12
15	1. Parent advice	Advice	-0.76	1.54	0.12
16	13. Assessment type	Subject characteristics	-0.80	1.60	0.13
17	18. Teacher like/dislike	Teaching	-0.94	1.62	0.13
18	2. Older peer advice	Advice	-1.26	1.57	0.12
19	7. Number of units	Logistics	-2.13	1.74	0.14
20	3. Peer advice	Advice	-2.22	1.64	0.13
21	8. Timetable fit	Logistics	-2.33	1.75	0.14

The sample size (n) for these descriptive statistics is 157.

In order to determine whether scores for consecutive factors were different, paired two sample, two tailed *t*-tests were conducted and the results are shown in Table 28. The null hypothesis is that there is no difference between the scores of consecutively ranked factors. The degrees of freedom for all statistical significance tests in Table 28 is 156.

Table 28: BWS-Accept inferential statistics comparing rankings

Rank	Factor	Differences between rankings	t - value	p - value	Significance
1	5. Interest expectation				
2	21. Need for career	1 - 2	1.98	.0497	*
3	12. Mark expectation	2 - 3	2.07	.0403	*
4	19. Need for future study	3 - 4	1.29	.1981	
5	6. Enjoyment experience	4 - 5	0.46	.6476	
6	10. Ability	5 - 6	0.92	.3597	
7	14. Classwork style	6 - 7	0.25	.8035	
8	15. Difficulty	7 - 8	4.92	.0000	***
9	20. Need for personal life	8 - 9	0.75	.4520	
10	11. ATAR scaling	9 - 10	0.10	.9218	
11	9. Information	10 - 11	0.41	.6825	
12	16. Teacher quality	11 - 12	0.44	.6628	
13	17. Teaching style	12 - 13	1.11	.2682	
14	4. Teacher advice	13 - 14	1.08	.2813	
15	1. Parent advice	14 - 15	0.95	.3459	
16	13. Assessment type	15 - 16	0.19	.8493	
17	18. Teacher like/dislike	16 - 17	0.78	.4346	
18	2. Older peer advice	17 - 18	1.67	.0969	
19	7. Number of units	18 - 19	4.80	.0000	***
20	3. Peer advice	19 - 20	0.53	.5977	
21	8. Timetable fit	20 - 21	0.61	.5431	

* $p < .05$, ** $p < .01$, *** $p < .001$

Table 28 shows there are statistically significant differences between the factors ranked first and second (5. Interest expectation and 21. Need for career), factors ranked second and third (21. Need for career and 12. Mark expectation), factors ranked seventh and eighth (14. Classwork style and 15. Difficulty), and factors ranked 18th and 19th (2. Older peer advice and 7. Number of units). There are no statistically significant differences between other consecutively ranked factors.

The seven factors that are most important to students in choosing a subject for future study are:

1. I will find the subject interesting. (Factor 5)
2. The subject could be useful for my career. (Factor 21)
3. I think I can get good marks in the subject. (Factor 12)
4. I will probably need the subject for my future study. (Factor 19)
5. I enjoyed the subject (or similar subject) in middle school. (Factor 6)
6. I got good marks in the subject (or a similar subject) in middle school. (Factor 10)
7. I will enjoy the classwork for this subject. (Factor 14)

The first two ranking items of enjoying a subject and usefulness in a career are most important in terms of their impact on decision making with the next five items being of similar importance to adjoining ranked factors.

Factors that were considered very unimportant in a students' subject choice decision are a student's need for extra units (Factor 7), a suggestion from friends (Factor 3) or the subject's fit with timetabling (Factor 8). As indicated in Table 28, there is no statistically significant difference between these three factors. There is a statistically significant difference ($p < .001$) between these lowest three items and "older students or siblings suggested doing the subject" that is next highest in the factor ranking. Teacher advice is ranked 14th which is consistent with Focus Group Phase findings that revealed that students did not consider the advice of teachers highly. Advice from parents, friends, older siblings and older students are all ranked even lower than the advice of teachers.

Students indicated that requiring a subject for future study and career are important factors. This is an interesting result given over 60% of students stated that they were unsure of their future study path.

Gender

The responses for male and female students responding to the BWS-Accept version of the survey were analysed separately and the results compared. Figure 6.7 shows a comparison of the BWS-Accept scores (± 1 *SE*) of male and female respondents for each of the 21 factors. The data used to create this graph is presented Tables D.1 and D.2 in Appendix D.

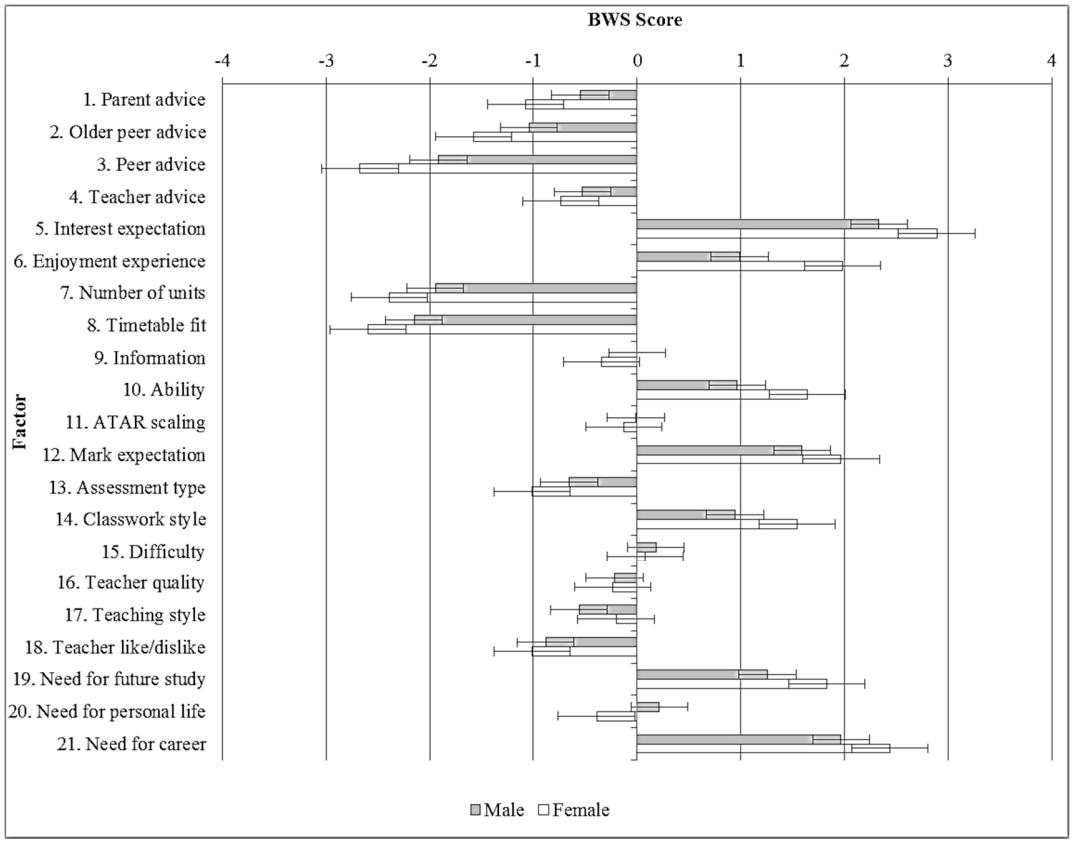

Figure 6.7: BWS-Accept comparison of mean male and female BWS scores.

The Pearson Correlation Coefficient between the mean female and male BWS-Accept scores for the 21 factors is .98.These results indicate that the pattern of scoring for BWS factors is very similar between male and female students suggesting that girls and boys ranked these factors in a similar manner.

Although the pattern is similar, there are statistically significant differences between male and female BWS-Accept scores for six of the factors; 1. Parent advice, 3. Peer advice, 6. Interest expectation, 10. Enjoyment experience, 14. Ability. Table 29 shows these statistically significant results. Inferential statistical analysis was conducted using *t*-tests that were two sample, two tailed, and assumed unequal variances (see Tables D.1 and D.2 in Appendix D for data). The null hypothesis is that for each factor, there is no difference between BWS-Accept scores for male and female students. The table shows that females scored advice from parents ($p < .05$) and peers ($p < .01$) lower than males did but ranked interest expectation ($p<.05$), enjoyment experience ($p<.001$), ability ($p<.05$) and classwork ($p<.05$) more highly than males.

Table 29: BWS-Accept male and female statistically significantly different scores

	Mean BWS-Accept Score		Male verses Female BWS Score			
Factor	Male	Female	Degrees of freedom (DF)	t - value	p - value	Signif-icance
1. Parent advice	-0.55	-1.08	119	2.07	.0409	*
3. Peer advice	-1.91	-2.67	135	2.92	.0041	**
5. Interest expectation	2.33	2.89	144	-2.00	.0469	*
6. Enjoyment experience	0.99	1.98	153	-4.11	.0001	***
10. Ability	0.97	1.64	139	-2.57	.0112	*
14. Classwork style	0.95	1.55	154	-2.27	.0245	*

* $p < .05$, ** $p < .01$, *** $p <.001$

These results indicate male and female students choose subjects in a similar manner but there are differences in the degree of importance students they placed on some factors. Girls regarded peer advice and parent advice even less important than boys in subject choice and considered being interested and enjoying a subject, their past ability and the type of classwork for a subject as more important than boys in their decision-making process.

Choosing Science

The responses to the BWS-Accept version of the survey for students who stated in the survey that they had chosen to study Science were analysed separately from those of the students who stated they did not choose a science. Figure 6.8 shows a comparison of the BWS-Accept scores (± 1 *SE*) of students who chose Science ("Science") and did not choose Science ("No Science") for each of the 21 factors. The data used to create this graph is presented Tables D.3 and D.4 in Appendix D.

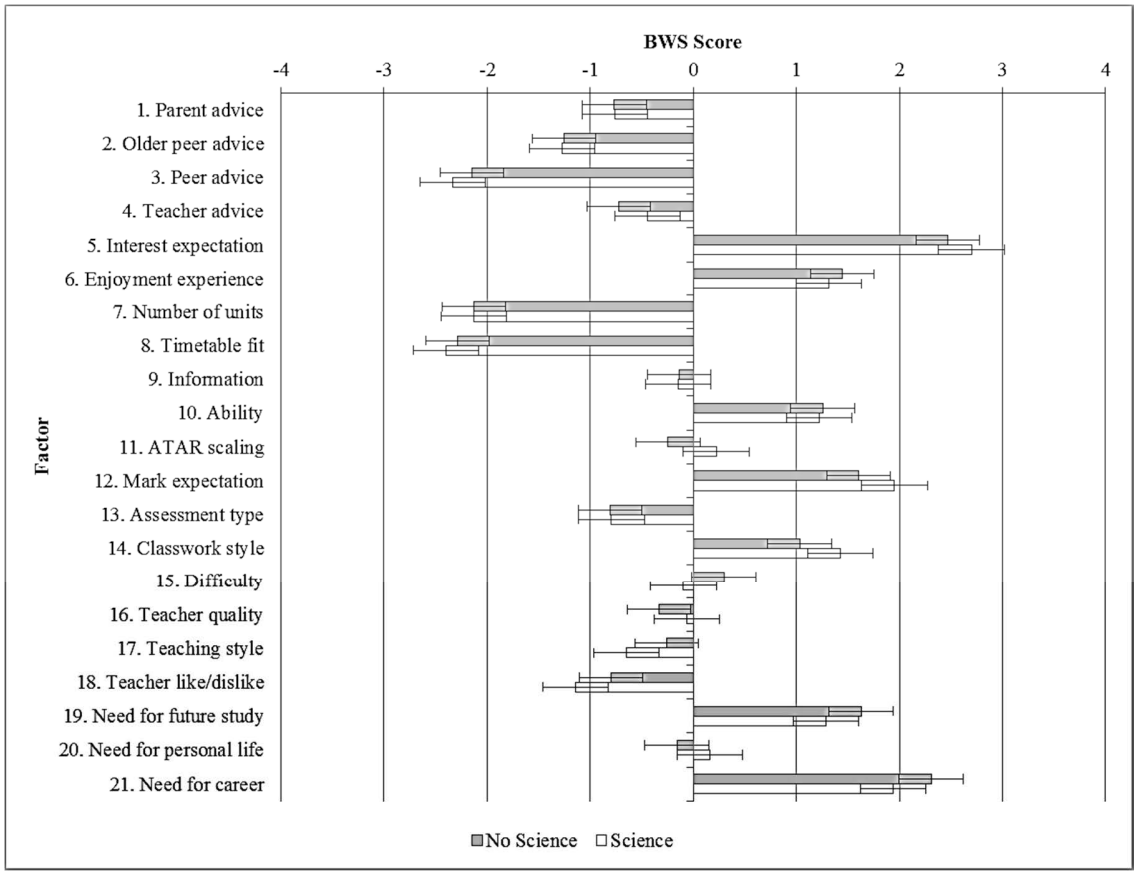

Figure 6.8: BWS-Accept comparison of mean BWS scores for students who indicated they did or did not choose Science.

The Pearson Correlation Coefficient between the mean BWS-Accept scores of students who stated they had chosen a Science and those who said they had not chosen a Science was 0.98. This finding indicates that students who choose or do not choose Science considered factors for choice of subject in a similar manner.

The differences between BWS-Reject scores of students who chose Science and those who did not choose Science and female respondents for each factor was analysed using *t*-tests that were two sample, two tailed, and assumed unequal variances (see Tables D.3 and D.4 in Appendix D for data). The null hypothesis is that for each factor, there is no difference between BWS-Accept scores for students who did and did not choose Science. Factor 1. Parent advice was the only factor that was scored statistically significantly differently at the < .05 level ($t(148) = -2.00$, $p = 0.0477$). Parental advice may be even less important for students who chose science ($M = -1.26$) than those who did not choose Science ($M = -0.76$).

6.4.3 **BWS-Reject**

The BWS-Reject survey allows ranking of the factors that students considered in rejecting a subject for study in Year 11. Figure 6.9 shows the BWS score for the 21 factors students considered when choosing which subjects they did not want to study in Year 11 at school. This figure shows the ranking of factors for choosing a subject from the most important at the top to the least important at the bottom. The data for this graph displayed in rank order is shown in Table 30.

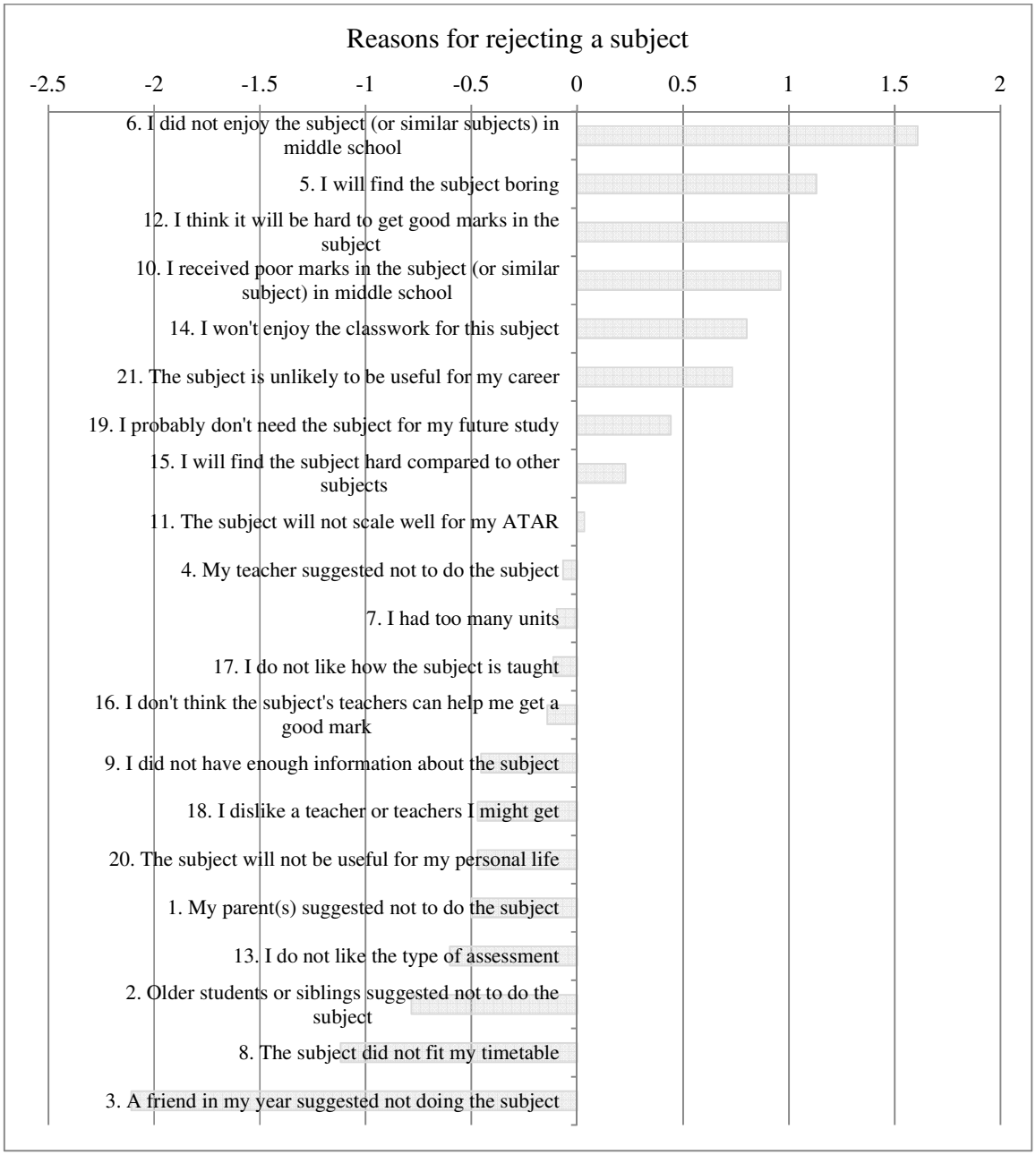

Figure 6.9: BWS-Reject: Reasons for rejecting a subject.

Table 30: BWS-Reject reasons for not choosing a subject - ranking and descriptive statistics

Rank	Factor	Grouping	BWS Score		
			Mean (M)	Standard Deviation (*SD*)	Standard Error (*SE*)
1	6. Enjoyment experience	Enjoyment and interest	1.61	2.01	0.15
2	5. Interest expectation	Enjoyment and interest	1.13	2.31	0.17
3	12. Mark expectation	Ability (marks)	0.99	1.78	0.13
4	10. Ability	ATAR scaling	0.96	1.87	0.14
5	14. Classwork style	Subject characteristics	0.80	1.65	0.12
6	21. Need for career	Ability (marks)	0.73	2.11	0.16
7	19. Need for future study	Usefulness	0.44	1.84	0.14
8	15. Difficulty	Subject characteristics	0.23	1.54	0.12
9	11. ATAR scaling	Ability (marks)	0.03	2.30	0.17
10	4. Teacher advice	Advice	-0.07	1.70	0.13
11	7. Number of units	Logistics	-0.10	2.17	0.16
12	17. Teaching style	Teaching	-0.11	1.67	0.13
13	16. Teacher quality	Teaching	-0.14	1.56	0.12
14	20. Need for personal life	Usefulness	-0.47	2.09	0.16
15	9. Information	Logistics	-0.45	1.64	0.12
16	1. Parent advice	Advice	-0.50	1.74	0.13
17	18. Teacher like/dislike	Teaching	-0.47	2.07	0.16
18	13. Assessment type	Advice	-0.60	1.70	0.13
19	2. Older peer advice	Advice	-0.78	1.74	0.13
20	8. Timetable fit	Logistics	-1.12	1.99	0.15
21	3. Peer advice	Advice	-2.11	1.87	0.14

In order to determine whether scores for consecutive factors were different, paired two sample, two tailed t-tests were conducted and the results are shown in Table 31. The null hypothesis is that there is no difference between the scores of consecutively ranked factors. The degrees of freedom for all statistical significance tests in Table 31 is 175.

Table 31: BWS-Reject inferential statistics comparing rankings

Rank	Factor	Differences between rankings	*t* - value	p - value	Significance
1	6. Enjoyment experience				
2	5. Interest expectation	1 - 2	2.37	.0094	**
3	12. Mark expectation	2 - 3	0.59	.2781	
4	10. Ability	3 - 4	0.20	.4219	
5	14. Classwork style	4 - 5	0.88	.1890	
6	21. Need for career	5 - 6	0.31	.3788	
7	19. Need for future study	6 - 7	2.21	.0143	*
8	15. Difficulty	7 - 8	1.13	.1306	
9	11. ATAR scaling	8 - 9	0.95	.1717	
10	4. Teacher advice	9 - 10	0.47	.3193	
11	7. Number of units	10 - 11	0.13	.4474	
12	17. Teaching style	11 - 12	0.08	.4681	
13	16. Teacher quality	12 - 13	0.19	.4233	
14	20. Need for personal life	13 - 14	1.52	.0646	
15	9. Information	14 - 15	-0.08	.4669	
16	1. Parent advice	15 - 16	0.27	.3929	
17	18. Teacher like/dislike	16 - 17	-0.13	.4485	
18	13. Assessment type	17 - 18	0.61	.2711	
19	2. Older peer advice	18 - 19	0.94	.1730	
20	8. Timetable fit	19 - 20	1.68	.0473	*
21	3. Peer advice	20 - 21	5.03	.0000	***

* p < .05, ** p < .01, *** p <.001

Analysis of the difference between consecutively ranking items shows there is a statistically significant difference between the scores for the first two ranked factors (6. Enjoyment expectation and 5. Interest expectation, $p = .04$). There are no statistically significant differences between consecutively ranked items until the sixth ranked item which is significantly different from the seventh ranked factor (21. Need for career and 19. Need for future study, $p < .05$). There are no statistically significant differences between other consecutively ranked factors until the comparison between rank 19 and 20 (2. Older peer advice and 8. Timetable fit, p<.05) and rank 20 and 21 (8. Timetable fit and 3. Peer advice, p<0.001).

The seven factors that are most important to students in rejecting a subject for future study are:

1. I did not enjoy the subject (or similar subjects) in middle school. (Factor 6)
2. I will find the subject boring. (Factor 5)
3. I think it will be hard to get good marks in the subject. (Factor 12)
4. I received poor marks in the subject (or similar subject) in middle school. (Factor 10)
5. I won't enjoy the classwork for this subject. (Factor 14)
6. The subject is unlikely to be useful for my career. (Factor 21)
7. I probably don't need the subject for my future study. (Factor 19)

The first items of enjoying a subject is the most important with the next five items being of similar importance to adjoining ranked factors.

Teacher advice is ranked 10th with advice from parents ranked 17th. Advice from older siblings and older students is ranked 19th. A friend's suggestion not to choose the subject was considered the least important factor in choosing which subjects to reject and was statistically significantly different (p <.001) from the second last factor, relating to the subject not fitting with a student's timetable. This is consistent with Focus Group Phase findings that revealed that students did not consider the advice of peers highly.

Gender

The responses for male and female students responding to the BWS-Reject version of the survey were analysed separately and the results compared. Figure 6.10 shows a comparison of the BWS-Reject scores (± 1 *SE*) of male and female respondents for each of the 21 factors. The data used to create this graph is presented Tables D.1 and D.2 in Appendix D.

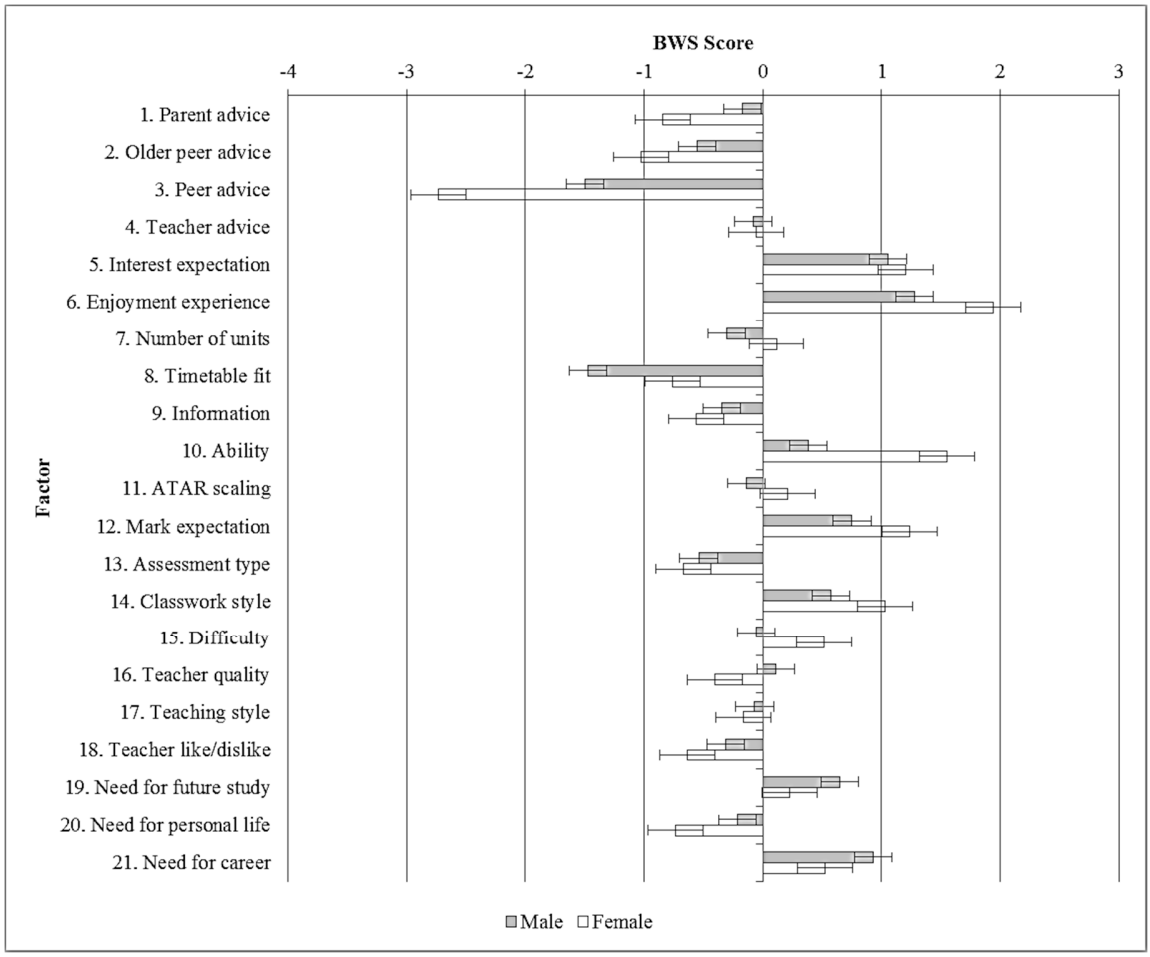

Figure 6.10: BWS-Reject comparison of mean male and female BWS scores.

The Pearson Correlation Coefficient between the mean female and male BWS-Reject scores for the 21 factors is .86.These results indicate that the pattern of scoring for BWS factors is very similar between male and female students suggesting that girls and boys ranked these factors in a similar manner.

Although the pattern is similar, there are statistically significant differences between male and female BWS-Reject scores for seven of the factors; 1. Parent advice, 3. Peer advice, 6. Enjoyment experience, 8. Timetable fit, 10. Ability, 15. Difficulty, and 18. Teacher like/dislike. Table 32 shows these statistically significant results. Inferential

statistical analysis was conducted using *t*-tests that were two sample, two tailed, and assumed unequal variances (see Tables D.1 and D.2 in Appendix D for all factors). The null hypothesis is that for each factor, there is no difference between BWS-Reject scores for male and female students. The table shows that females scored parent advice, peer advice and teacher like/dislike lower than males did but ranked enjoyment experience, timetable fit, ability and difficulty more highly than males.

Table 32: BWS-Reject male and female statistically significantly different scores

Factor	Mean BWS-Accept Score		Male verses Female BWS Score			
	Male	Female	Degrees of freedom (DF)	*t*-value	*p* value	Signif-icance
1. Parent advice	-0.17	-0.84	167	2.59	.0105	*
3. Peer advice	-1.49	-2.74	172	4.66	.0000	***
6. Enjoyment experience	1.28	1.94	173	-2.21	.0287	*
8. Timetable fit	-1.47	-0.76	174	-2.42	.0168	*
10. Ability	0.38	1.55	173	-4.34	.0000	***
15. Difficulty	-0.06	0.52	168	-2.50	.0133	*
18. Teacher dislike	0.11	-0.40	174	2.21	.0282	*

* p < .05, ** p < .01, *** p <.001

These results indicate male and female students reject subjects in a similar manner but there are differences in the degree of importance students they placed on some factors. Similar to the result for choosing subjects, girls regarded peer advice and parent advice, and disliking a teacher even less important than boys in rejecting a subject. Girls considered their past ability and difficulty of a subject as more important than boys in their decision-making process.

Choosing Science

The responses to the BWS-Reject version of the survey for students who stated in the survey that they had chosen to study Science were analysed separately from those of the students who stated they did not choose a science. Figure 6.11 shows a comparison of the BWS-Reject scores (± 1 *SE*) of students who chose Science ("Science") and did not choose Science ("No Science") for each of the 21 factors. The data used to create this graph is presented Tables D.3 and D.4 in Appendix D.

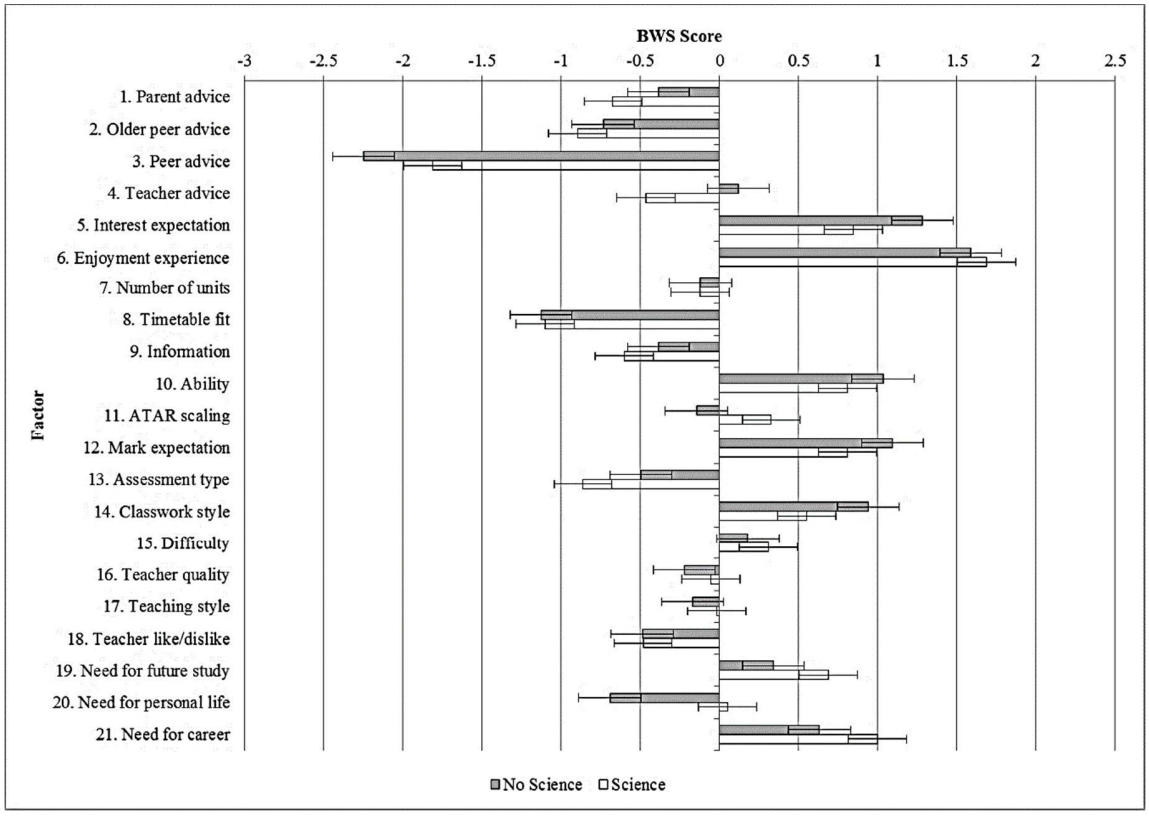

Figure 6.11: BWS-Reject comparison of mean BWS scores for students who indicated they did or did not choose Science.

The Pearson Correlation Coefficient between the mean scores for students who did choose Science and did not choose Science for BWS-Reject was .92. This indicates the responses from students who chose Science and those who did not choose Science are very similar.

The differences between BWS-Reject scores of students who chose Science and those who did not choose Science and female respondents for each factor was analysed using *t*-tests that were two sample, two tailed, and assumed unequal variances (see Tables D.3 and D.4 in Appendix D for data). The null hypothesis is that for each factor, there is no difference between BWS-Reject scores for students who did and did not choose Science. Two factors were scored as statistically significantly differently ($p < .05$) by students who did and did not choose Science – 4. Teacher advice and 21. Need for personal life. Teacher advice was considered more important, but still relatively unimportant, by students who had chosen Science (Science students $M = 0.12$ verses no Science students $M = -0.47$; $t(137) = 2.32$, $p = .0221$). The need for a subject in a student's personal life was considered less important, but still relatively unimportant, by students who chose Science than those who did not choose Science (Science students $M = -0.69$ verses no Science students $M = 0.05$; $t(119) = -2.31$, $p = .0226$). This indicates that students who chose Science or did not choose science reject subjects in a similar manner. However, compared to those students who did not choose a Science, those who chose Science considered the advice of teachers as more important but considered Science as relatively *less* important in their personal lives.

6.4.4 **BWS-Accept and BWS-Reject**

This section presents a summary of the results from the BWS-Accept and BWS-Reject versions of the Fresh Minds survey.

Overall, scores for BWS-Accept are higher than those for BWS-Reject, indicating more agreement on the importance of factors students used to choose subjects than those they used to reject subjects. Figure 6.12 shows a comparison of BWS scores (± 1 *SE*) for the two versions of the survey. The data used to produce this graph are presented in Table 27 (BWS-Accept) and Table 30 (BWS-Reject). The range in scores for BWS-Accept (Range 4.89, Minimum -2.33, Maximum 2.56) is greater than for BWS-Reject (Range 3.73, Minimum -2.10, Maximum 1.62) indicating that students felt more strongly, or were in

more agreement, regarding their ranking of the factors they used to choose subjects than they were about the factors they used to reject subjects. This may indicate that students have a broader range of reasons that they use to reject subjects.

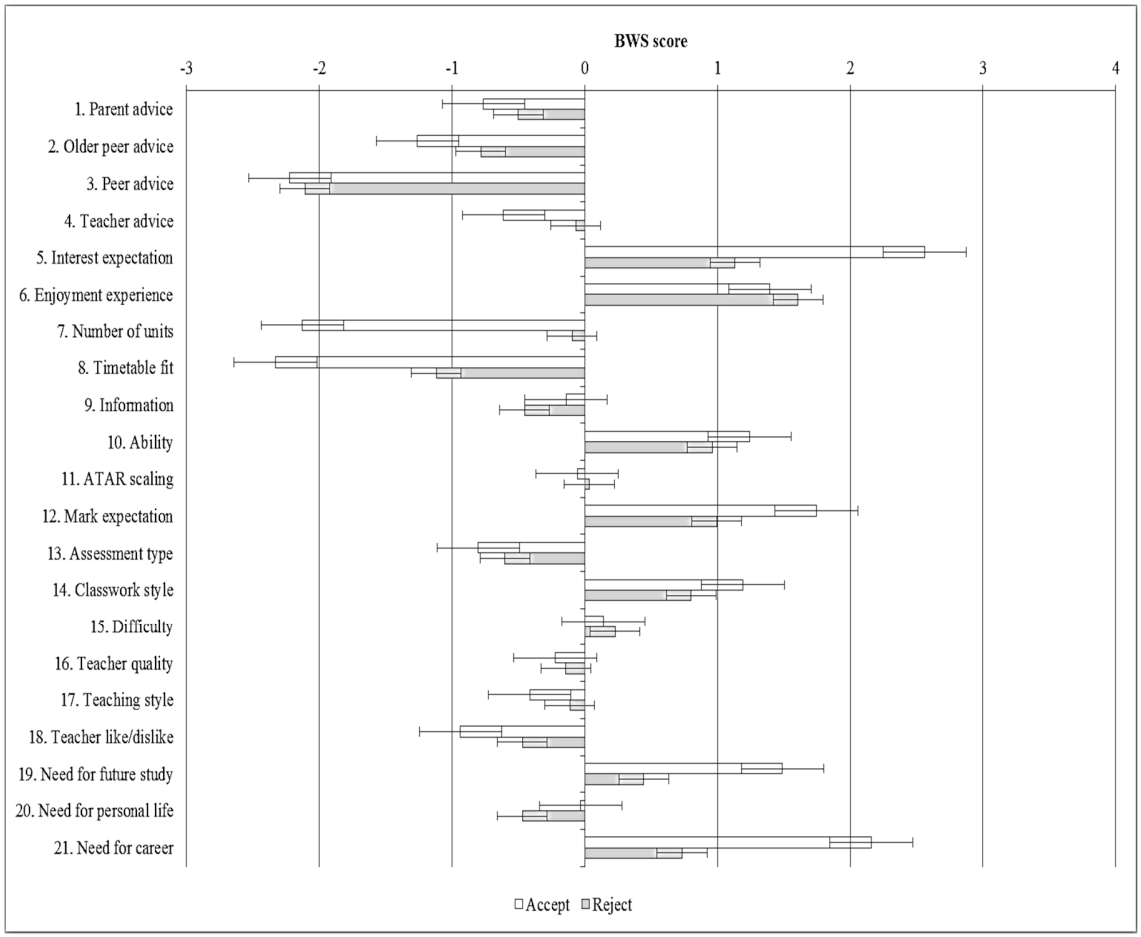

Figure 6.12: Comparison of responses to BWS-Accept and BWS-Reject surveys.

A comparison of scores for the BWS-Accept and BWS-Reject versions of the survey is presented in Table 33, followed by a description of the major conclusions from each grouping of factors. Within Table 33 the seven most important factors for BWS-Accept and BWS-Reject, are highlighted in grey and the ranks shown. This shows that the same seven factors are important in accepting and rejecting subjects but the order in which these factors

are ranked is different depending on whether students are considering whether to accept or reject subjects. This supports the idea that students consider these two viewpoints differently.

Table 33: Comparison of BWS-Accept and BWS-Reject scores

	BWS-Accept		BWS-Reject	
Factor	Mean (M)	Rank	Mean (M)	Rank
Advice				
1. Parent advice	-0.76		-0.50	
2. Older peer advice	-1.26		-0.78	
3. Peer advice	-2.22		-2.11	
4. Teacher advice	-0.61		-0.07	
Enjoyment and interest				
5. Interest expectation	2.56	1	1.13	2
6. Enjoyment experience	1.39	5	1.61	1
Logistics				
7. Number of units	-2.13		-0.10	
8. Timetable fit	-2.33		-1.12	
9. Information	-0.14		-0.45	
Ability (marks)				
10. Ability	1.24	6	0.96	4
11. ATAR scaling	-0.06		0.03	
12. Mark expectation	1.75	3	0.99	3
Subject characteristics				
13. Assessment type	-0.80		-0.60	
14. Classwork style	1.19	7	0.80	5
15. Difficulty	0.14		0.23	
Teaching				
16. Teacher quality	-0.22		-0.14	
17. Teaching style	-0.41		-0.11	
18. Teacher like/dislike	-0.94		-0.47	
Usefulness				
19. Need for future study	1.49	4	0.44	7
20. Need for personal life	-0.03		-0.47	
21. Need for career	2.16	2	0.73	6

The results from the groupings of factors as shown in Table 26 are now discussed.

The first four factors assessed how students ranked the importance of advice they received from parents, older peers or siblings, peers and teachers. Students did not consider suggestions from other people as important in choosing or rejecting a subject. Students completing both the BWS-Accept and BWS-Reject survey version were in agreement

regarding the relative unimportance of advice from any source. Peer advice was considered the least important factor in both accepting and rejecting a subject. These findings are broadly consistent with student and adult perceptions of the importance of advice revealed in the Environment and Focus Group Phases. In these phases, adults indicated that they doubted whether students listened to advice and students stated they were not highly influenced by advice. However, adults in the Environment Phase did indicate they thought some students listened to parents and that many students listened to peers. Students in the Focus Group Phase indicated they listened to the advice of older peers or siblings but this finding is not reflected in the BWS-accept nor BWS-reject results.

The low ranking given to the advice of peers and older siblings, is interesting given the results from the Focus Group Phase, where students indicated they sought out advice from these groups but did not choose subjects based on the choices of their friends. Adolescents are believed to be sensitive to their social environment (Silvers et al., 2012) and the findings from the BWS study may indicate that students' social environment is complicated with respect to subject choice. Students may be unwilling to admit to, or are unaware of, the extent of social influence. Further, the manner in which the questions were framed in the BWS may have led to students rationalising their decisions, as has been observed for adults (Shafir, 1993; Tversky & Kahneman, 1986, 1991). Students may have reacted strongly to the suggestion that they had chosen a subject based on the advice of peers and thus ranked it as the worst choice when the factor was presented. Adults in the Environment Phase stated that they stressed to students the importance of not choosing subjects based on the advice of peers, and students in the Focus Group Phase stated they would not choose subjects based on the advice of peers. The impact of a student's normative environment on subject decision and the effect of question framing on how students rank advice remains unclear. However, the evidence from this BWS study is that students themselves did not believe that the advice of peers was important when choosing subjects, compared to the other factors they considered.

Interest and enjoyment are ranked as important factors for subject choice. Factors 5 and 6 asked students whether the subject will be interesting (or 'boring') and about their previous enjoyment experience of a subject or similar subject in middle school. Students

ranked both of these factors as relatively more important in deciding which subjects to study and which to reject. It should be noted that interest is not equivalent to 'enjoyment while learning' because enjoyment can occur for many reasons in addition to interest (Krapp & Prenzel, 2011). This suggests that both interest anticipation and enjoyment experience are critical factors in the decision-making process. This finding is in agreement with the conclusions of the Focus Group and Environment Phases of this study.

Students ranked factors associated with the logistics of subject choice (factors 7, 8 and 9) as less important than most other factors. Needing extra units or having too many units, the fit of a subject within a timetable, and information provided about subjects were all considered relatively unimportant. These findings suggest that students did not feel limited in their subject choices by the availability of the subjects or by a lack of information about the subjects and support conclusions drawn from the Focus Group Phase of the study. Relative to other factors under consideration, the number of subjects students could take, or were required to take, was not a key decision factor in their choosing subjects.

A student's perception of their ability was assessed with factors 10, 11 and 12. These factors considered a student's past performance, their beliefs about a subject's usefulness for calculation of the ATAR and expected performance (mark expectation). Students' past performance, expected performance and their expectation of "getting a good mark" were all relatively important factors in choosing subjects. However, contribution towards an ATAR is not amongst the most important factors. The lower ranking of the ATAR factor may be the result of framing of the question because students may be sensitive to the suggestion that they are considering their ATAR when adults had advised them not to consider the ATAR when choosing subjects. Notwithstanding this, there is evidence from the Focus Group Phase that students did consider the contribution of a subject to their ATAR when choosing subjects.

The format of the subject was considered in the subject characteristics grouping addressed in factors 13, 14 and 15. The factors within this grouping considered by students in the BWS survey referred to whether they liked or disliked a subject's assessment style or style of classwork. Students found the style of classwork important in choosing and

rejecting subjects. Students ranked the difficulty of the subject within the factor "I will find the subject easy/difficult". Students ranked difficulty of a subject relative to other subjects as an important factor in their deliberations. This finding agrees with statements made by students and adults participating in the first two phases of Fresh Minds.

Teaching was considered a relatively unimportant factor in students' subject selection decision making. Factors 16, 17 and 18 relate to a students' perception of the quality of teaching, teaching style and relationship they may have with a potential teacher for a subject under consideration. Quality of teaching was measured by a student's perception of a teacher's ability to help them obtain good marks. Teaching style related to how students believed a subject would be taught. The potential relationship with a teacher was assessed by the like or dislike they felt for a potential teacher. Although students spoke of teaching frequently in the Focus Group Phase and adults considered teaching important, as revealed in Environment Phase, teaching was not amongst the factors identified in the BWS study that students considered most important in their decision making.

Students did not consider teaching as an important factor in subject choice, compared to the other factors presented. This is consistent with the findings of Quinn and Lyons (2010) that teachers are less likely to attribute the decrease in enrolments to Science teaching than to characteristics of the student. Students in the focus groups expressed the view that their enjoyment of a subject was important for subject choice and this was linked to the teaching of the subject. As enjoyment of a subject is shown in the BWS survey as the most important ranked factor in subject choice, the role of teaching as may play an important role as it influences students' enjoyment of a subject. This represents a further area of investigation of the relationship between teaching and subject enjoyment for Science.

The usefulness of a subject for future study plans, personal life and future career in subject selection was explored in the final three factors. The results were mixed and depended on the type of need defined for a subject and whether students were considering which subjects to choose or reject. The need for a subject for a student's career and future study is ranked as an important factor in the decision to accept or to reject a subject. This

indicates that students will study a subject if they need it for a career or future study but not necessarily reject it because they do not. The usefulness of a subject for a student's personal life was considered a less important factor in choosing and rejecting subjects when compared to the other factors presented.

6.5 Summary

This chapter presents findings from the Fresh Minds survey, which addressed the research questions: What factors do students consider when choosing their subjects for Years 11 and 12 at school? and, What is the relative importance of the factors that students consider in choosing their subjects for Years 11 and 12 at school?

This phase of the the study collected quantitative data regarding aspects of student subject choice decision making, students' ideas about Science choice, and the relative importance of factors that students considered.

The data show that students are at different stages of surety concerning their choice of future study path or career and they hold different views on the difficulty of the subject selection process. The relationship between career surety and subject selection difficulty suggests that students who have decided on their career or future study plans select subjects appropriate to this plan and hence found the process easier. The large number of students who had not chosen a career found subject choice more difficult.

This chapter also presents a list of factors that students considered in their subject selection decision and evaluates the relative impact of these factors using BWS. The factors for choice are ranked differently. In addition, these factors are assessed differently depending on whether students were deciding to choose or reject a subject.

This survey shows that students placed relatively little importance on the advice they were given about subject choice. Students also did not rank past and anticipated teaching and logistical issues highly in their deliberations.

There is little evidence that male and female students approach the subject selection process in a different manner but there are differences in the level of importance boys and

girls place on certain factors. The girls in this study considered past academic performance in a subject as a more important consideration in choosing subjects to reject than boys did.

Within this study, according to the TRA framework, the behaviour is defined as the action of choosing subjects and the outcome is that these subjects will allow students to pursue a career or study plan of choice. Behavioural and normative beliefs are the proximal antecedents to choice within the TRA theoretical framework. These results suggest that behavioral beliefs may play a dominant role in subject choice. Enjoyment and interest in a subject and the ability of students to obtain "good marks" in a subject are indicated as key factors in subject choice. The normative beliefs formed as a result of interactions with peers, family and experts within the school environment appear to be of much less importance in the decision making process than the behavioural beliefs.

Students' intent to choose particular subjects may be impacted on by the perceived control they have over their behaviour. The determination of the level of control students have over their subject choices is important because the TRA behavioural model assumes the individual has control over the behaviour of interest. The action of making a subject choice is within the student's control. However, the impact of that action on their future career or study path is not. This is particularly the case for students who do not know their future career.

The Fresh Minds survey provides key information relating to factors that form the intention to choose particular subjects. Should the intention to study Science be based on the same ranking factors, then this this has important implications for encouraging students to study Science. Influencing the intention to study Science may be best accomplished by strategies directed to the formation of an attitude towards choosing Science. Strategies to influence students' perceptions of enjoyment and interest in Science and the perception of difficulty of the subject, in association with career factors, represent the main areas in which student decision making may be influenced.

This chapter concludes the presentation of the results from the Fresh Minds for Science study. The next chapter presents conclusions based on these results.

CHAPTER 7: **Conclusion**

7.1 Introduction

This chapter presents a discussion of the findings of the Fresh Minds study and suggests three strategies that respond to the primary research question: How might more students be influenced to study Sciences in Years 11 and 12?

The three-phase approach adopted in Fresh Minds allowed strategies to be formulated and directed at encouraging more students to choose a Science subject for study in their final years of school. The Focus Group Phase explored students' perceptions of subject choice, the factors students considered in choosing their subjects and the decision process they used to evaluate these factors. The Environment Phase investigated the environment within which students made their subject selection decision; the information and advice they received to inform their decisions. The final phase, the Survey Phase, determined the relative importance of the factors students used to choose their subjects.

The remainder of this chapter comprises five sections. Section 7.2 provides an overview of findings relating to students' subject choice behaviour. Section 7.3 describes choice of subject as it specifically relates to the choice of Science at school. A marketing analysis of the results from this study are presented in section 7.4, and section 7.5 describes three strategies aimed at increasing student uptake of Science subjects. Section 7.6 discusses the limitations of this study and Section 7.7 suggests directions for future directions for this research. The final section, 7.8, presents conclusions to the Fresh Minds study.

7.2 Choosing subjects

This section outlines the main findings from this study under the headings of student characteristics, subject characteristics and choice process, in line with the themes identified in this research relating to student subject choice. This analysis addresses the following research questions which are concerned with students' information-seeking characteristics and decision-making characteristics:

- What decision-making process do students use to decide which subjects to study for Years 11 and 12 at school?

- What factors do students consider when choosing their subjects for Years 11 and 12 at school?

- What is the relative importance of the factors that students consider in choosing their subjects for Years 11 and 12 at school?

- What information are students provided with to assist them in choosing their subjects for Years 11 and 12 at school and how is this information assessed by them?

7.2.1 **Student characteristics**

Students indicated in the Focus Group Phase that interest and enjoyment were very important considerations in choosing their subjects and this finding is supported by the BWS rankings from the Survey Phase of Fresh Minds. Within the Focus Group Phase, the nodes of 'ability' and 'interest and enjoyment' contained many comments which were coded to both these nodes, thus indicating that these two factors are closely linked.

The Survey Phase showed that students did rank not past teaching or future expectations regarding teaching highly in their subject choice decision. Although students spoke of teaching experiences and quality of teaching frequently in the Focus Group Phase of the study, teaching factors were shown in the BWS analysis to be neither strongly important nor strongly unimportant in their subject choice decisions. These findings contrast with the views of the adults in the Environment Phase who stated that they believed that student subject choice was strongly influenced by teaching experiences and expectations.

Male and female students expressed similar views about subject choice in the Focus Group Phase, except that the girls appeared more likely to discuss their subject choices with friends than boys were. The BWS results showed that male and female students ranked the factors for choosing and rejecting subjects in a very similar manner supporting the view

that gender is not an important consideration in the decision process students use to choose or reject subjects.

7.2.2 **Subject characteristics**

The BWS survey showed that students considered the difficulty of subjects, the style of classwork for subjects, and anticipated future career and future study as important in deciding which subjects to accept and reject.

Classwork was discussed in the focus groups, with some students expressing preference for subjects that were fact based, for example Science and Mathematics, and others preferring subjects in the humanities that involved more discussion and opinion. Although students ranked the style of classwork as important in choosing and rejecting subjects, the type of assessment for a subject was relatively unimportant.

The difficulty of a subject, particularly with respect to Science, was commented on by both adults in the Environment Phase and students in the Focus Group Phase. Adults and students considered subject difficulty important in subject selection, as difficulty was seen to affect a students' ability to perform well in a subject. Students stated that obtaining marks for the HSC was important and adults agreed that this was a concern for students. Students also stated that the ATAR was not a primary concern for them and the BWS study produced a similar finding. Given the link between HSC marks and the calculation of the ATAR, this apparent conflict is interesting. The apparent relative importance of the ATAR may be the result of the framing of the questions posed to students or because students had been told specifically that they should not be concerned about the ATAR. Notwithstanding student comments that they would not avoid subjects because they were difficult, the BWS survey showed that student perceptions of how difficult it would be to obtain high marks in a subject were very important in choosing and rejecting subjects.

Students participating in the focus groups made judgments about how useful a subject was likely to be for their future career or study needs. The BWS results revealed that both usefulness in a career and the need for a subject for planned or potential tertiary courses were important in choosing subjects and somewhat important in rejecting subjects.

The Survey Phase showed that students were at different stages of surety concerning their choice of future study path and this level of surety is correlated with how difficult a student found the subject selection process. Although the usefulness of a subject in a student's education or employment pathway was important in subject selection, the usefulness of a subject in a student's personal life was not an important factor for either choosing or rejecting subjects. This suggests that students considered the selection of school subjects in terms of their requirements for a future career or tertiary study rather than as a source of broadly useful skills.

7.2.3 **Choice process**

Students in the focus groups felt they were well informed about potential subjects. This is supported by the findings from the Environment and the Survey Phases of the study. The survey showed that students generally had adequate access to information about subjects they could choose. The BWS analysis found that students ranked the information they received as a relatively unimportant factor in their decision making. This ranking could indicate that students felt sufficiently informed about subject choices and thus the information they received was not considered an important factor in their choice.

Students in the focus groups stated that they listened to and valued the advice of peers, particularly those in older Years. They stated that they found the general advice from adults on how to approach the subject selection process to be useful. However, students were suspicious of subject-specific advice if it came from teachers recommending their own subject. The BWS study results indicate that advice from parents, peers, older peers, or teachers was seen as relatively unimportant in the subject decision-making process. This apparent contradiction, particularly with respect to advice from older peers, may be due to students considering advice more generally when the topic was discussed in the focus groups but relating advice to choice of specific subjects when considering advice as a factor for choice in the BWS study.

The subject choice decision was described similarly by both genders as involving two stages. The first stage was acceptance or rejection of subjects about which the students felt strongly. This was followed by a second stage involving a detailed analysis of

remaining subjects. Students spoke of the first stage in the selection process in emotive terms (“love”, “hate”), suggesting that this immediate acceptance or rejection of subjects is in the affective domain. In the second stage of the decision process, students engaged in a more detailed evaluation of their options and appeared to consider a large range of factors. This stage in the decision process appears to be less emotive and involves a higher level of reasoning.

Students indicated they considered a range of factors when choosing their subjects for Years 11 and 12. The list of 21 factors determined in the Focus Group Phase were evaluated using BWS in the Survey Phase. Seven of these factors were statistically significantly more important to students in the subject selection decision process than the other factors presented in the BWS survey. Table 34 summaries the rank order for the top seven factors that influenced students’ subject choices, as revealed in the BWS analysis in section 6.4. These seven factors are the same for accepting and rejecting subjects but the order of these items are ranked is different.

Table 34: Top seven reasons to choose or reject a subject for Years 11 and 12 at school

Reasons to choose a subject	Reasons to reject a subject
Interest expectation	Enjoyment experience
Need for career	Interest expectation
Difficulty	Difficulty
Need for future study	Ability
Enjoyment experience	Classwork style
Ability	Need for career
Classwork style	Need for future study

7.3 Choosing Science

This section summarises the key findings from the Fresh Minds study that respond to the research question: What perceptions do students hold regarding the value of choosing Science for the final years of school?

Science subjects were generally perceived by both students and adults within the participating schools as being more difficult and content laden relative to other subjects that students could choose. Students differed in their perceptions of whether the classwork style of Science subjects was predominantly fact based or directed at understanding concepts. Students in the focus groups showed preferences for different classwork styles, and classwork style was an important factor in the BWS study. Student perception of the relative difficulty and content of Science subjects may encourage some students to take a Science subject and others to avoid choosing a Science.

Some students stated that they indicated that they needed a range of subjects to maintain career and study options if they were unsure of their future career path. Students generally expressed the view that Science is a discipline that prepares students for a narrowly defined range of occupations. Science was not perceived as a generally useful subject affording skills that would be useful outside of traditional scientific roles.

7.4 Marketing of Science

This section addresses the primary research question: How might more students be influenced to study Sciences in Years 11 and 12? This section is written from a marketing perspective and discusses the value of Science, the marketing mix for Science, and suggests marketing strategies that may be attempted for influencing choice.

7.4.1 **Target market**

Not all customers have the same needs, and so marketers segment the market into groups of customers with similar needs and then choose the segment that presents the greatest opportunity (Elliott et al., 2010; Kotler & Keller, 2012). A means of defining potential customers for studying Science in Years 11 and 12 is to divide students into three segments: those who feel strongly positive about studying Science, those who are undecided, and those who feel strongly negative about studying Science. Within this segmentation, the target market that represents the greatest opportunity for marketing to be effective are those students who are undecided and likely to evaluate Science at the time of 'purchase' to determine its value to them. Students with strong positive or negative views

of Science over time are unlikely to have that view influenced at the time subjects are selected.

7.4.2 **The value of Science**

Customers choose products based on which of the products offered is seen to deliver the most value (Elliott et al., 2010; Kotler & Keller, 2012). Value is determined by customers according to their perception of the benefits in terms of the quality and service relative to the costs of purchase. Value is a trade-off between the perceived costs and benefits of a product. From a marketing perspective, students are assessing subjects for study in Years 11 and 12 in terms of each subject's value to the individual and how this value compares with other available choices.

The results of this study suggest that students assess the costs of a subject in terms of the investment in work, time and resources that will be required in a subject to obtain an appropriate benefit for that effort. This effort is related to the perceived difficulty of a subject because additional effort is required to obtain good marks in a difficult subject. A subject's benefit is measured by students in terms of enjoyment and interest, usefulness as a contribution to their ATAR, and whether or not the subject is needed for a future career or study path.

Science may be perceived as having a higher cost than other subjects. Science subjects are perceived as difficult, with more demanding content than many other subjects. Science may be seen as requiring more effort to produce results, which means it is perceived as having a higher price.

The benefits from studying Science are both emotional and rational. The emotional benefit relates to the joy of learning, inherent interest in the subject matter, and the way in which Science enables understanding of the world. Students ranked enjoyment and interest most important in choosing subjects. The rational benefits relate to students' achievement not just in terms of high marks but also the knowledge required to enable them to pursue a chosen, or potential, study or career path. Students indicated that the likelihood that they will obtain high marks in a subject is a very important consideration in choosing a subject.

Students who may wish to go into a traditional science-based occupation recognise the need to study a Science for the HSC.

A model for target-market students' assessment of the value of Science is presented in Figure 7.1. This figure is based on Figures 4.7 to 4.11 of Chapter 4. The model suggests some considerations made by students who are undecided about choosing Science. For simplicity, this diagram shows a sequence of steps and the possible outcomes based on students making a positive or negative assessment of the value of Science at each step. It is not suggested that students follow this exact decision path or that these factors are being considered independently. Indeed students may being making a holistic decision but, based on the findings of this study, these are be the types of issues that students may be considering.

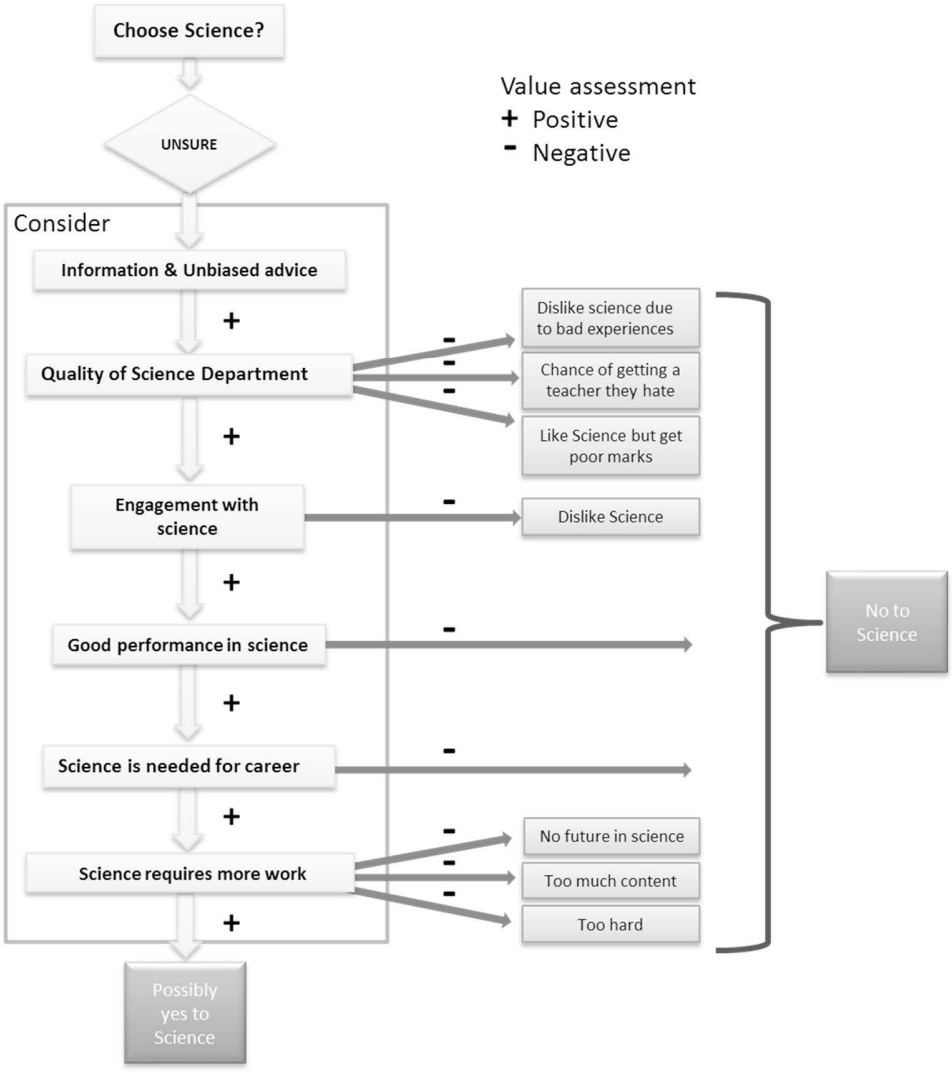

Figure 7.1: Value assessment model for students who are undecided about Science.

If we assume that students who are undecided about choosing Science determine the value of Science to them as described here, then there are numerous potential reasons for these target-market students to reject Science. The assessment of value is doubly disadvantaged by students' perception of Science being a subject which is more difficult than other subjects and hence more 'costly' whilst also being perceived as having limited use outside of a career in Science.

If Science is perceived as a poor-value subject, then students are less likely to choose a Science subject if alternative lower cost (in terms of return on effort) subjects are available. If this perception of value is based on incomplete or incorrect knowledge, then value may be misjudged. When perception of value is believed to be underestimated, marketing can address perceptions of cost and benefits. Improving students' perception of the value of Science, relative to other subjects, can therefore be approached by reducing perceptions of cost and increasing the perceptions of benefits.

The additional benefits of studying Science that do not appear to be recognised by students are the broadly applicable capacities of analytical and critical thinking skills. These skills, which allow students to develop a greater understanding of complex issues in society and the framework to make informed decisions in a range of occupational and private settings, did not appear as important benefits to be gained from further study in Science.

7.4.3 The marketing mix

Marketers have traditionally categorised marketing activities in four areas referred to as the 'marketing mix', namely, product, price, place, and promotion (Kotler & Keller, 2012). Issues related to marketing Science subjects to students by schools or other stakeholders is discussed with in this section with reference these four areas.

Product

Modifying each senior Science subject through curriculum or pedagogical changes would constitute the common marketing strategy of a 'product development'. A product development strategy for Science might be aimed at changing the classroom experience of Science perhaps through teacher education such that the product 'Science' is perceived as being more valuable to students. This may be accomplished by reducing the level of content for Science subjects or the complexity of the content to reduce the perceived cost of studying Science. The benefit of Science may also be increased by changing the nature of the content or pedagogy so that students enjoy studying Science or find it more interesting.

Changing the product 'Science' is problematic because it presupposes that lower than desirable participation is due to student dissatisfaction with the actual product in its current form. In the Fresh Minds survey, 38% of students who gave reasons for not choosing science stated that a dislike of Science was part of this choice. If the majority of students rejecting science do not dislike the subject, and the subject choice decision for the target market is based on rational grounds, then changing Science subjects may not encourage more students to choose Science. Rather, changing the classwork style for Science subjects, either in content or pedagogy, may discourage students who have a preference for the way Science is currently presented. Students expressed preferences for certain styles of classwork in the focus groups and ranked classwork style as an important factor in the BWS study. Changing the pedagogy or content of Science lessons may also make Science less attractive to those who currently choose Science. A change in Science as a 'product' may exacerbate rather than ameliorate the issue of unsatisfactory enrolments.

Whilst acknowledging the risks of changing Science as a product, enhancing positive experiences in the Science classroom in middle school may be worthwhile in a marketing sense to improve the interest in, and enjoyment of, Science. Few would argue that improving the experience of Science in the classroom is not worthwhile in its own right as a means to enhance learning. Students reported that they are influenced to choose subjects based on their past experience in subjects. They noted the impact of negative experiences on their enjoyment of Science, particularly if these experiences occurred near to the time of subject choice. Given people react more strongly to negative experiences than positive ones when making decisions, changing the experience of Science would require not only enhancing positive experiences but, perhaps more importantly, minimising negative experiences. However, ensuring a student's exposure to positive teaching experiences and removing negative experiences is not within the marketer's complete control. This means the success of a strategy based on improving the experience of the product 'Science' relies on a consistent positive experience in the Science classroom in the middle years of schooling, and particularly close to the time subject choice is made. From a marketing perspective, such a long-term strategy to sustain positive experiences and avoid negative experiences is difficult to sustain. Notwithstanding this limitation, teacher

education programs may be enhanced by including topics that inform future Science teachers of their impact on students' perceptions of the difficulty and usefulness of Science, and how these impact on the choice of Science.

Price

Students appear to assess the cost or 'price' of subjects in terms of the effort required to produce high marks. There was evidence from the focus groups that some students were avoiding effort by looking for subjects that they found easier. However, this view was not commonplace and is not supported by the results from the BWS study. These results suggest that students may not avoid subjects if they perceive the additional effort required but more to provide a "return on investment" in terms of generating marks. The BWS study shows that the ability and expectation of students to obtain "good marks" in a subject are important factors in subject choice. Focus group results show that Science is generally perceived as more difficult than other subjects available to students. If students assess the price of Science in terms of the effort they need to expend to obtain the benefit of good marks, then the price of Science may too high relative to other subjects.

Promotion

Promotion relates to how the product benefits are communicated to customers. Students have beliefs regarding the outcome of choosing Science; these are the product benefits of Science. Students see Science careers as narrowly defined for stereotypical Science careers such as engineering, medicine or becoming a scientist. If the only benefit of studying Science is preparation for what students perceive as a career in science, then those who cannot envisage themselves in a stereotypical Science career will be unlikely to choose Science. Then, the skills to critically evaluate evidence and come to independent conclusions based on that evidence may be worthwhile promoting to students. Students completing the BWS survey ranked the importance of a subject in their personal life as relatively unimportant. Promoting Science on the basis that Science teaches students reasoning skills may be effective if this can be linked to the importance of these skills in future study or career.

Promoting Science may also be effective if students are given confidence that they will be able to succeed in understanding the subject Science they are learning and that their effort will be reflected in good marks. This may be accomplished in several ways. For example, teachers can explicitly show students how they will be assisted in gaining good marks in Years 11 and 12. Reducing the perception of difficulty may also be accomplished by ensuring students' have positive experiences in Science in the months prior to subject choice and therefore to feel capable of succeeding in the subject.

An important issue with promoting Science to students is their evaluation of the advice they receive. In the BWS study, students ranked the advice they receive from parents, teachers, and peers on choosing subjects as unimportant. Students also indicated in the focus groups that they are aware of marketing practices and are wary of subjects that are marketed to them. If students are resistant to having their view of subjects influenced by others, it may be difficult for teachers to communicate with them to change their perceptions of Science. However, students may respond to promotion that allows them to make their own decision as to the relevance of Science in their lives based on credible information. This information needs to come from a source that they believe is unbiased.

Place

Place is the method used to deliver a product or service to the customer. For students, place refers how and where in the school environment students gain access to subjects they can 'buy'. The results of the Environment Phase show that the process of subject selection is structured and students are able to choose Science if they wish to. It is not viable to change student access to Science subjects. However, the information students require to make their subject decision presents a promotional opportunity within the place facet of the marketing mix. The marketing opportunity is to promote Science at the time of 'purchase' by redressing the view that Science is only associated with stereotypical scientific careers.

7.5 Strategies for influencing choice of Science

This section provides an answer to the strategy-oriented research question: What marketing-informed strategies can be suggested to increase the numbers of students choosing to study Science in Years 11 and 12 at school? Based on the analysis within the

four key marketing areas of product, promotion, place and price, three strategic objectives are proposed for increasing the probability of students choosing Science. These strategies may be implemented within schools by the schools or by other groups with an interest in promoting Science study. These are related to behavioural and normative belief constructs within the Theory of Reasoned Action as shown in Figure 7.2.

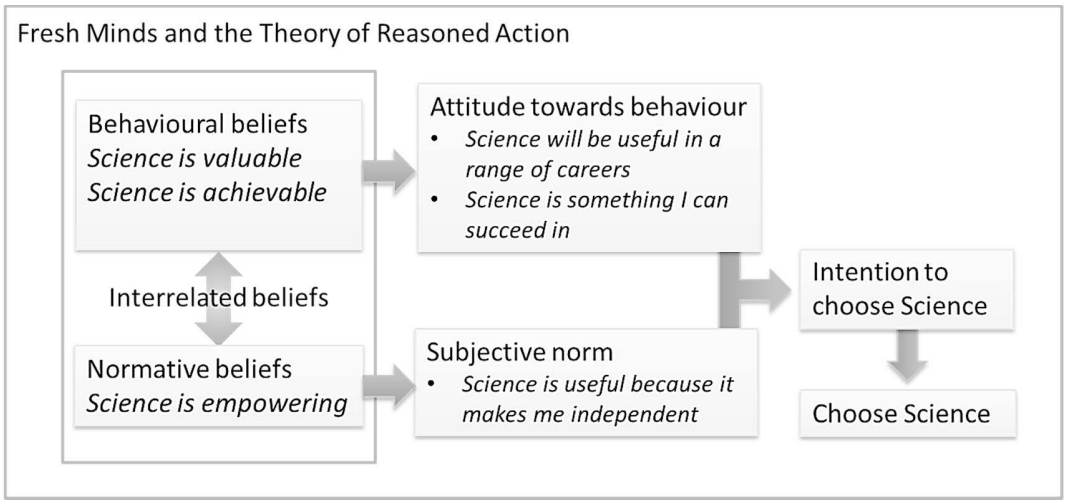

Figure 7.2: Fresh Minds and the Theory of Reasoned Action.

Each of these strategies is described in the following sections and proposals are made with examples of possible approaches that may be employed to accomplish each strategic objective.

7.5.1 **Science is valuable**

The first strategic objective is directed at the behavioural beliefs held by students regarding the outcome of choosing Science. The objective is to increase the perception of the value of Science by demonstrating the worth of Science in a range of careers. This strategy draws on the fact that many people who graduate from Science degrees are successful in fields other than Science. Many businesses utilise Science skills that may not be obvious to adolescents,

for example quality control and production functions within food companies or financial institutions that invest in Science or engineering-based companies. The movement of Science graduates into a range of different fields, including those outside of their Science discipline, can be used as an indicator that a Science degree is useful in non-scientific careers (McInnis, Hartley, & Anderson, 2001; Rodrigues et al., 2007). Students who are choosing their subjects may be influenced to consider Science if they were aware of the broader value of a Science education.

An approach to support the strategy 'Science is valuable' could be to use testimonials from successful individuals who started in Science and then used the skills from a Science degree in their careers outside of Science. Such testimonials could describe how Science knowledge has enhanced their career options and even their lives more generally. Students may be encouraged to consider the role of Science in developing the higher order thinking skills necessary for success in a future study and career. Support for such an approach can be found by considering student views on Mathematics. Mathematics is thought by students to be generally useful, rather than simply a subject that prepares a student for a career as a mathematician. A similar approach could be used marketing Science as a way to develop scientific literacy and analytical skills that are transferrable to a range of students' current and future work and study contexts.

The view that Science is valuable may also be enhanced by presenting a view of Science subjects during the subject selection period that extends beyond technical information. Revising this information to highlight the broader applicability of Science may entice students to regard Science as a more useful subject than they had previously thought.

7.5.2 **Science is achievable**

The 'Science is achievable' strategy aims to address the perception that Science is inherently more difficult than other subjects. This view affects the behavioural beliefs of students with respect to their ability to succeed in a subject. As previously mentioned, changing the perception of the subject's difficulty could potentially be accomplished by designing students' experiences in Science during the months prior to subject choice in ways that help them feel capable of succeeding in the subject.

According to TRA, the interplay of attitude to the behaviour and the perceptions formed as a result of the social environment in which the students develop leads to the intention to behave in a certain way. For students without strong feelings about Science, this intention may not yet been formed and so the importance of the events that immediately precede selection may influence this intention to choose Science. When making decisions, adolescents are known to have high temporal discounting which means that compared to adults, they will place more importance on what has recently happened or is anticipated in the short term than in the long term (Whelan & McHugh, 2010). The effect of high temporal discounting is that a positive or negative experience in Science just prior to subject selection may have a strong influence on the subject being accepted or rejected.

An approach to address this strategy could involve topics students find most enjoyable and interesting being taught in the weeks leading up to subject selection. In addition, it may be prudent for teachers to take care with assessments for Science in the weeks prior to subject selection to ensure these are not unduly challenging. Scaling of results from difficult assessments in Year 10 may also be considered as an approach to prevent students underestimating their level of self-efficacy with respect to Science. The intention of these strategies is to increase students' perception of their ability in Science by allowing them to fairly assess their performance in the subject in Year 10 relative to other subjects.

7.5.3 **Science is empowering**

The final suggested strategy is Science is empowering and is aimed at helping students develop the view that Science teaches important skills which support independent thought. This strategy is based on the supposition that students can find additional value from Science through the valuable cognitive skills that Science instils.

An approach to helping students to see how Science is empowering could draw on the influence of older peers. Adolescents like to be treated as individuals who care about their world and to receive their information in manageable packages from a 'friend' (Elliott et al., 2010). Students in the Focus Group Phase of this study stated that they listened to advice from older peers, who were identified as an impartial sources of information.

Students in this study stated they did not experience social pressure to select particular subjects. Nevertheless, the decisions of adolescents are influenced by their social environment and it is likely that subject choice is a decision that is impacted upon by students' normative beliefs (Fishbein & Ajzen, 2010; Santrock, 2010). Asking past students of Science to speak to current school students about their experiences after choosing Science may influence students to reconsider Science. Students in higher Years of school, along with university students who have experienced the usefulness of their Science study, could be invited to speak to Year 10 students to extol the benefits of continued study in Science. If students who are undecided and evaluate Science at the time of 'purchase' are the greatest marketing opportunity for Science, then using university students and students who were similarly undecided about their own choice of Science for the HSC may be particularly valuable.

7.6 Study limitations

The sample type and size limits the generalisability of the results from the Fresh Minds study. The schools in this study were from a small suburban region of a large city and non-government schools were over-represented. The schools were well resourced and in areas with high socio-economic status. For students at these schools, university study upon completion of school was commonplace. These students are unlikely to be representative of students generally.

The perception of marketing may also limit the impact of this study. Marketing to children is a concerning issue for many adults, and for some even the concept of using marketing in a school environment is unpalatable. This discomfort may come from the power that marketing has to inform and influence, particularly with respect to children (Le Guay, 2003). Yet, this power of marketing to children is the reason for using such a useful tool for analysing and influencing students' choice of Science. The strategies suggested here will need to be used responsibly to address adolescents' conceptions of Science but not to direct them into a subject for which they are not suited. Based on modern marketing principles (Kotler & Keller, 2012), the use of marketing strategies to encourage students to choose Science if they have shown no interest in the subject or are unlikely to succeed in it

would not only be a disservice to the student but also poor marketing practice. The objective is to assist students to make a properly informed choice rather than to 'sell' them Science if it is not an appropriate subject for them.

7.7 Future research

The findings drawn from Fresh Minds data can be validated and the generalisability expanded by further research in three key areas: 1) repeating this study in a range of geographical and socio-economic regions, 2) determining whether Science is chosen in the same manner as other subjects, and 3) conducting a study that considers the trade-off of factors for subject choice.

This study was conducted in an urban area and largely with students of high socio-economic backgrounds. Students in rural areas have been found to have more negative views of Science than their city counterparts (Lyons & Quinn, 2010) and students from lower socio-economic groups are known to be less likely to choose to study Science (Ainley et al., 2008). Given the sample limitations of this study, appropriate further research could include repeating this study a wider sample of schools in urban and rural regions with differing socio-economic status.

The subject selection decision investigated with BWS was not specific to the choice of Science. Important information about how students choose Science could arise from a repetition of the BWS using the same factors but asking students how important these factors were for choosing Science specifically.

This study proposed a decision-making process for student choosing their subjects in Year 10. BWS revealed the relative importance of the factors that students considered in their decision-making. Developing a richer understanding of the way in which students use these factors to reach a decision could be accomplished by conducting a Discreet Choice Experiment (DCE) (Coast, Flynn, Salisbury, Louviere, & Peters, 2006). BWS reveals relative rankings for factors considered in a decision but does not provide data on how these factors are traded-off against one another. A DCE study presents respondents with sets of factors as scenarios and asks respondents to choose between these scenarios. A DCE

investigating the factors that influence Science choice would further elucidate the compromises that students make when choosing subjects as they trade-off different costs and benefits.

The strategies suggested by Fresh Minds can be tested through an intervention within a school or schools to measure the effect of implementing one or more of the marketing approaches suggested by this work. The intervention could be used to measure the effect of these approaches in improving Science subject selection. The effect might be measured by comparing student surveys before and after the intervention to determine any change in students' behavioural intentions with respect to choosing Science. The uptake of Science in the intervention group could also be compared to past year groups to give an indication of a change in behaviour towards Science as a result of the intervention.

This marketing-inspired research can also be extended by using the methods employed in Fresh Minds is to investigate why students discontinue Science in Years 11 and 12. A study of 'customer retention' could reveal not only why students leave Science but also how the perception of Science meets the reality of studying Science for the HSC. The methods in Fresh Minds could also be utilised to investigate how students choose university courses and why students choose to pursue Science at a tertiary level.

7.8 Summary

The aim of the Fresh Minds for Science study was to understand how students choose their subjects for study in Years 11 and 12 at school and how the choice of Science is influenced by this decision process. This study proposes that the student may be considered as a potential customer of Science and therefore students are evaluating the subjects they could choose in terms of their perceived value. The strategies suggested to change student behaviour are based on a marketing approach underpinned by the behavioural model of the TRA.

It is not claimed that the decision-making process is the only thing that needs to be taken into account when considering the issue of Science subject selection. On the contrary, the findings of this study indicate that a variety of interrelated factors lead to a student's decision to choose or reject Science for study in Years 11 and 12 at school. Nonetheless, is it is clear that this turning point in Year 10, when the selection decision is made, is a critical step in the path towards the acquisition of valuable scientific skills for themselves and society.

The group that presents the greatest opportunity for increasing the selection of Science are those students who are undecided about whether to continue with Science at the time subject choice is made. Influencing students who reject Science on emotive grounds in the first stage of their subject choice decision process to reconsider is difficult. Challenging students' perceptions regarding the costs and benefits of choosing Science by encouraging them to view success in Science as valuable, achievable and empowering has the potential to increase participation in the Sciences generally.

The findings here suggest that most students rejecting science are making a rational choice based on their perceptions of the costs and benefits of choosing Science. The cost is measured predominantly in terms of effort to produce marks. The benefit is how useful Science will be in to a student's future. This usefulness is twofold - Sciences' ability to gain the marks necessary for the ATAR to gain entry to university courses and the need for Science knowledge in a future career. When Science is evaluated as a subject for choice,

the perceptions students hold about these costs and benefits will influence their choice of Science.

This work has implications for encouraging more students to study Science. To alter student perceptions of Science at the time students are making their choice requires a change in how Science is promoted. Science is seen as a challenging subject with limited use in terms of both its contribution to a high ATAR and in its usefulness in a broad range of careers. The three strategies suggested are targeted at enhancing the perception of Science so that it is seen as valuable to a students' future, that success in Science is achievable, and that Science is empowering with value beyond a career. These strategies do not depend on a fundamental change in science pedagogy or content. Instead, they are designed to provide students with credible and relevant information that helps them reappraise the value of Science and decide that Science has a place in their future.

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Appendices

Appendix A: Summary of rules relating to Higher School Certificate and Australian Tertiary Admissions Rank

This appendix provides a summary of the rules relating to study of the Higher School Certificate in NSW, Australia as outlined by The Board of Studies, Teaching and Educational Standards NSW (BOSTES, NSW Government, 2011) and the Australian Tertiary Admissions Rank (ATAR) outlined by the Universities Admission Centre (Universities Admission Centre, 2012).

HSC candidates are required to take five to seven subjects including English which is compulsory. Most subjects are 2 units which equates to 4 hours of instruction in the subject per week (120 hours per year). Some subjects are also available in 1 or 3 units. Year 11 is termed 'preliminary year' and students must satisfactorily complete a minimum of 12 units in their preliminary year before commencing the HSC in year 12. Students must complete a minimum of 10 units to be awarded the HSC. These units can be made up of Board Developed Courses and Board Endorsed Courses. However Board Endorsed Courses cannot be counted towards a student's Australian Tertiary Admissions Rank (ATAR).

Both the Preliminary and HSC Courses must include:

- At least 6 units of BOSTES Developed Courses (additional courses endorsed but not developed by BOSTES may be included)
- At least 2 units of English (included in the 6 units above)
- At least 3 courses of 2 units or more units
- At least 4 subjects (including English)
- A maximum of 6 units of courses in Science.

The HSC is calculated 50% on the school based assessment and 50% through external exam administered by BOSTES. These external examinations may include practical examinations and written works.

Vocational Education and Training (VET) subjects are vocational based courses which require 35 hours of work placement and 120 hours of coursework. These subjects

may not have exams. Only BOSTES Endorsed VET subjects can count towards the calculation of a student's ATAR.

The HSC is for all students completing the requirements for the certificate. The ATAR is a rank of a student's performance relative to other students completing the HSC during the same year and is used for students wishing to attend university. The ATAR is calculated using scaled marks. These scaling is determined based on the quality of the students in the cohort in a year for each subject. The scaled results from the best 8 units of a student plus 2 units of English are combined to produce a student's ATAR. In 2014, 42 non-language subjects (including English) and 63 language subjects were approved for calculation of a student's ATAR. In addition 13 subjects were permitted to be included in the calculation provided no more than two units came from any of those subjects (UAC, 2014).

chools place additional requirements on students however these BOSTES rules must be adhered to in order for students to be awarded the HSC and, if applicable, an ATAR. Students may be required to study additional units, be limited in the number of additional units they may undertake or be required to study a Religion subject.

Appendix B: Information to participants

This appendix contains documents used in the data collection stage of *Fresh Minds*. The text in these documents is identical to the original but the formatting has been modified to fit these pages.

This appendix contains the following documents:

Document B.1: Information to schools

Document B.2: School process cheat sheet

Document B.3: Adult consent

Document B.4: Student consent

Document B.5: Adult interview fact sheet

Document B.6: Focus group fact sheet

Document B.1: Information for schools

FRESH MINDS FOR SCIENCE

9 April 2013

Using marketing science to help school science

Fresh Minds for Science is a doctoral study by Tracey-Ann Palmer of the University of Technology Sydney. The study is looking at encouraging more students to choose science as an elective at school.

Fresh minds for science

USING MARKETING SCIENCE TO HELP SCHOOL SCIENCE

ABSTRACT FOR THIS STUDY

Traditional approaches to inspire Australian children to continue with science into the senior school and through into university appear to be failing. Marketing to children is known to be effective and yet this powerful tool has not been utilised to understand why modern students fail to be as attracted to science as previous generations. This research aims to determine whether marketing theory can provide a new understanding of why this problem persists. To do this the research considers the student from a new point of view; as a customer with science as a product within a complex market of alternative choices. A rigorous marketing analysis of student subject choice behaviour will be conducted to create new knowledge about how students think about science as a subject. Such marketing analysis is designed to inform strategies that allow science to be packaged into an attractive offer that appeals to modern students. This study represents an important additional perspective in analysing student behaviour and it is anticipated it will provide new and innovative approaches to addressing the pressing problem of forecasted shortfalls in the supply of scientists.

Contact details

PhD candidate: Tracey-Ann Palmer

[redacted] Phone [redacted]

Supervisor: Associate Professor Peter Aubusson

Peter.Aubusson@uts.edu.au Phone 0295 145 264

INTRODUCTION

This document provides some information to schools considering participation in my doctoral study “Fresh Minds for Science: Using marketing science to help school science”. This is a summary of information provided in detail on the study’s website www.freshmindsforscience.weebly.com. After this introduction, this document has four main sections dealing with the significance of this work, your school’s participation, procedural risks and ethical considerations, and a timetable for the study.

SIGNIFICANCE OF THIS WORK

In this research I will address the science graduate shortage problem using a unique perspective; marketing theory. I come from a background in science and marketing and believe that my education and experience to this point has been ideally suited towards completion of this study. I have completed a Bachelor of Science with Honours in Biochemistry, worked as a scientist and then studied an MBA and worked in marketing, I returned to science studying a Bachelor of Teaching in Secondary Education in 2010 which, in concert with observations of my own teenagers, led to an interest in adolescent development and the flow of future scientists. It is the combination of educational and business experience which allows me to look at the issue of science enrolments from a marketing point of view.

Although significant work is already being done to make science more attractive, marketing has potential in providing contemporary techniques for attitudinal analysis and providing novel strategies for behavioural adaptation to meet these needs for society. Modern marketing has borrowed intensively from sociological, psychological and economic theories and introduced modern scientific methods to analyse behaviour beyond what people think they are doing to how they make choices and what the key influences are (Tadajewski & Jones, 2008). Marketing analysis provides a unique insight because it analyses the situation with a view to identifying a customer’s needs and satisfying them. Marketers have identified children as being susceptible to their techniques and engagement of this target market group is so powerful and effective that in Australia it restricted by consumer legislation and voluntary industry codes (Australian Association of National Advertisers, 2009; Le Guay, 2003). The work conducted in this area within education has approached the problem by seeking to understand student’s attitudes to science and what influences them. A marketing approach analyses the situation without assuming there are problems with the product or its delivery but focuses on understanding what the customer perceptions with a view to changing

behaviour to ensure the customer's needs are met. The primary research question based on a marketing approach is: Can rigorous marketing research methods and analysis be used to make science more attractive to student 'customers'?

In summary, current strategies to increase enrolments in science are generally focused on correcting perceived inadequacies in science and the way it is taught. Marketing theory will allow the problem to be seen from a new perspective which does not assume there is a problem with science itself but that thorough analysis of modern students as 'customers' and the environment within which they choose their subjects will reveal where there are opportunities for promotion. The next section provides information on how your school can participate in this study.

YOUR SCHOOL'S PARTICIPATION

The research design is based on a rigorous market research analysis which is used to create a marketing plan that is used in business. The market research will be conducted in three ways: focus groups, surveys and observations of students and the people within a school environment who influence their decisions to choose science. Because the research is with teenagers the research method exploits digital technologies where possible. The focus groups will be coordinated through schools to ensure a valid sample and conducted as face-to-face groups or using a digital interface if preferred. The surveys will will be informed by the results of these focus groups and by observations of the environment within which students choose their subjects at school. The observations of the environment of choice (e.g. careers nights) will include collection data on information provided to students as well as how and by whom this information is presented.

Methodology

Primary research data will be collected from students who have made and who are about to make a decision about choosing science at school. In addition, the environment within which the decision is made will be analysed. These two areas of enquiry form the primary data for the study. Secondary research data will take the form of information that has been collected by other researchers that is relevant to this study.

Participants and sampling

The research will involve participants from four schools, two public and two private schools. An additional school will be invited to be a pilot school for methodology testing. Key science industry bodies, tertiary education providers, employers within science and school advisers will also be contacted to determine their opinions regarding the issue of students choosing science.

Focus groups will be chosen as a sample from year 10 and 11 in consultation with the participating school. Only students in a position to choose science will be included (i.e. they must be passing the subject). Year 11 groups will be segregated into groups who did and did not choose science.

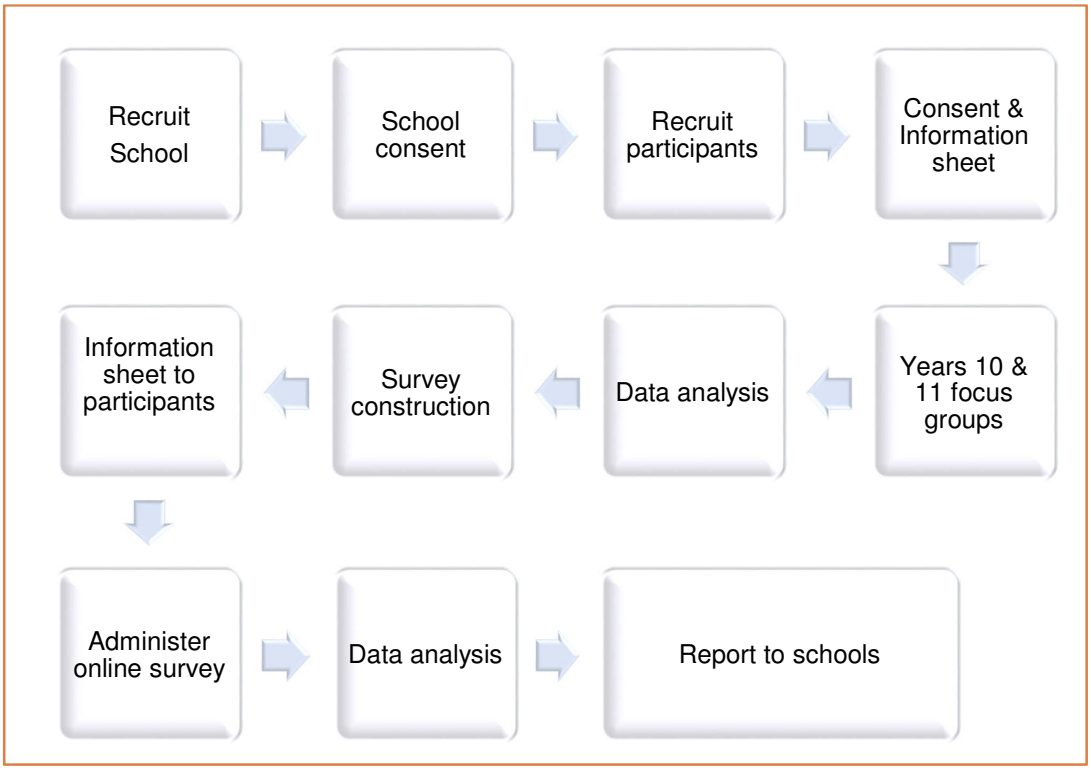
The survey will be piloted before being presented to participants. Pilot survey participants need to be similar to students who will be completing the digital survey. They will test the survey for non-sampling errors such as confusing wording. All students from year 10 and 11 of participating schools will be invited to complete the online survey through a secure site which identifies their school of origin but does not identify them as individuals. If possible, year 10 students will re-enter the online survey to provide information on their choice of subject when these are finalised. No student will be excluded from the study should they wish to participate.

Anyone can complete the survey as a non-secure guest on the website although the intention is to collect data from senior school students. These additional data will be analysed separately. Participant's contact details for use in the focus groups will be obtained through the participating schools.

FIGURE 1: SAMPLING OF STUDENT PARTICIPANTS.

Sample type	Participant numbers	Estimated time commitment per participant
Focus group	2 year groups (year 10 and 11) x 2 groups of 6 students. 24 students in total.	45 minutes
Online survey	Year 10 and 11 cohort.	15-20 minutes
School staff stakeholder interviews	1 career adviser, 2 science teachers, 1 year co-ordinator from each school plus others as recommended by the school.	30 minutes
External stakeholders	Representatives from key industry bodies and employers within science (minimum of 5) and marketing executives (2)	1 hour (not in schools)

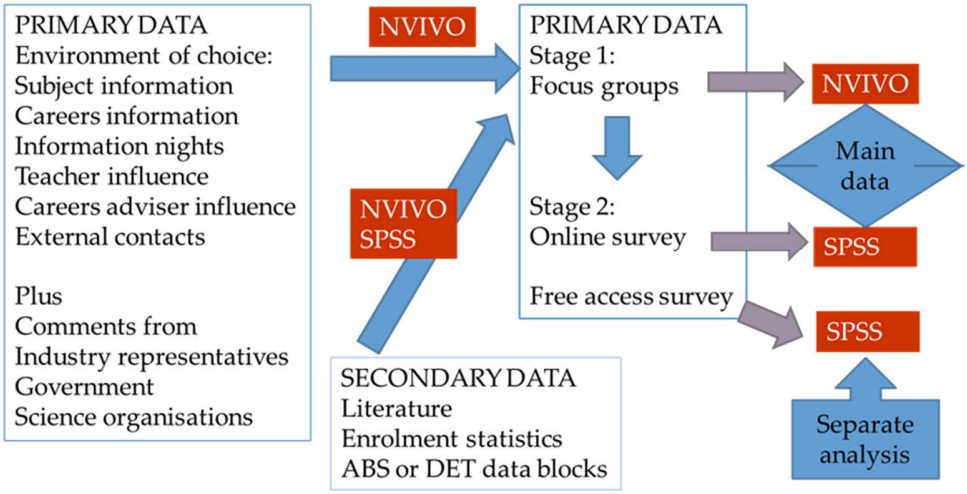
FIGURE 2: DATA COLLECTION *SE*QUENCE



Data analysis, storage and protection

Qualitative and quantitative data will be collected within this study. The first in stage in primary data collection will be to conduct online focus groups with students prior and post the decision to or not to choose science. It is anticipated that the focus group questions will aim to develop an understanding of the belief and control framework within which the choice of science is made. An overview of how data will be collected and analysed is shown in the following figure. NVIVO is software is recognised as being valuable in analysing qualitative data to identify relationships and allow the important factors affecting student decision making to be identified. Survey numerical data will be analysed using the statistical package SPSS.

FIGURE 2: DATA FLOW AND ANALYSIS DIAGRAM.



Your school will be provided with a summary of results from this work and in addition the results will be published in the study's doctoral thesis and academic papers.

Data will be collected from students will be anonymous and school name will be replaced by a code. Adult data will have identifying information removed and replaced by codes. Codes will be stored separately and password protected. Any identifying information that students add in free-field areas of surveys will permanently deleted.

There is a risk that adults may be identified from reading their comments, care will be taken when drafting publications to minimize this risk.

Data is stored securely at UTS for a minimum of 5 years.

PROCEDURAL RISKS AND ETHICAL CONSIDERATIONS

This project has approval from UTS HREC (UTS HREC 2012-392) and is currently awaiting approval by *SE*RAP for use in Government schools. The table which follows outlines risks associated with Fresh Minds for Science and how these will be addressed.

FIGURE 3: RISK AS*SE*SSMENT TABLE

Focus Groups		
Risk to participants	Magnitude of risk	Likelihood of risk

Students may join the focus group and find the process of sharing information about what they feel uncomfortable. Students may feel uneasy with an adult guiding the discussion and viewing its progress.	Risks are considered to be negligible. The information sought about subject choice is unlikely to be sensitive to participants.	The likelihood of risk from focus groups of adolescents is slight.

Risk assessment table continued… **Risk of methodology**	**Magnitude of risk**	**Likelihood of risk**
Focus groups have been criticized for the following shortcomings: **Participants can over-rationalise their behaviour and misrepresent their true motivations.** **Emotional behaviours aren't displayed.** **Participants may make up answers.** **Poorly run groups give poor data.** **Dominant people can dominate the group.** **(Krueger & Casey, 2009)**	 Moderate Low Moderate Low Low	Teenagers like to give their opinions in a digital forum. There is a risk they will try to over-justify why they have chosen or not chosen science. The moderator will need to look for signs of this. It is unlikely the choice was emotional and the digital interface should minimize individual dominance.
Online surveys		
Risk to participants	Magnitude of risk	Likelihood of risk
Survey participants may feel obliged to participate rather than volunteering because they have been told to by their teachers. This may cause them distress if teachers do not make it clear that the survey is optional and that participation will not affect their grades.	Negligible. The information sought about subject choice is unlikely to be sensitive to participants.	The risk of students in this age group feeling coerced into completing the survey is slight.
Methodology risk	Magnitude of risk	Likelihood of risk
I might not find anything new! **Students may not know why they choose what they do** **Schools may not be representative** **Limitations of focus groups & surveys** **Technical problems with survey** **Low response rate for survey** **Issue of getting data at the best time** **Ethics of producing results that are inappropriately used.**	Risks in this area are low but the study may need to be revised if these become apparent.	Low but manageable.
Consumer behaviour observations		
Risk to participants	Magnitude of risk	Likelihood of risk
Adult interviewees may feel uncomfortable about sharing their opinions.	Negligible. The information sought about subject choice is unlikely to be sensitive to participants.	There is a slight risk that adults may still agree to be interviewed even when uneasy because they feel obliged to give an opinion about what happens with children.

The risks associated with this study have been evaluated, are manageable and have been presented to the HREC and been accepted as justifiable. The following section will now present a proposed timetable for the study. Specific times would be discussed with your school to minimize disruption to staff and students.

TIMETABLE FOR THE STUDY

In term 1, 2013 I am contacting school principals and inviting selected schools to participate in the study. In negotiation with the principal (or representative), 2 groups of 6 students from each of years 10 and 11 will be chosen to participate in focus groups. Participants will be rewarded for participating at the discretion of the school principal (e.g. with an iTunes voucher or lunch).

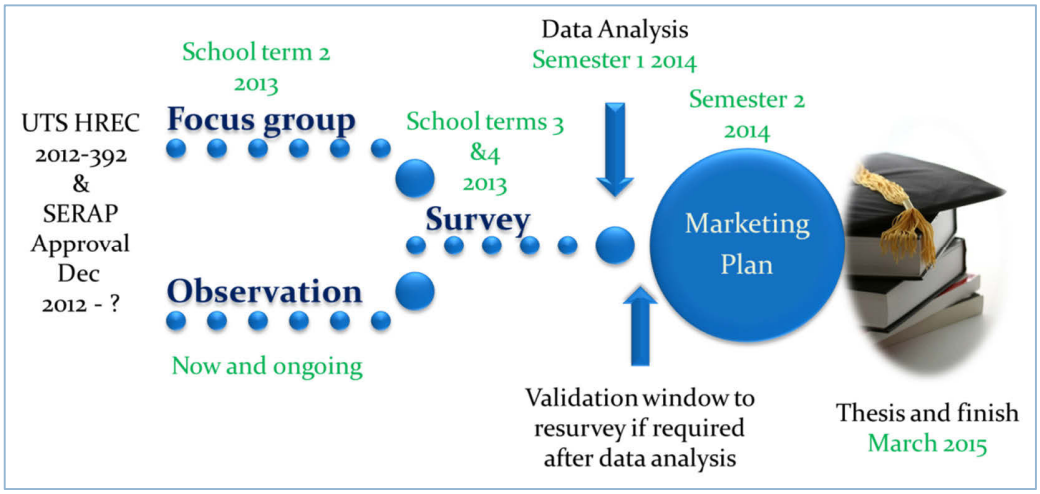
Permission will be sought from the school to review information relating to subject choice, observe any school events related to choice and to interview key stakeholders within the school.

In term 3 and/or 4 of 2013 (whenever subject choice is made), students in years 10 and 11 will be invited, through the school, to log into a survey to provide information on their subject choice intentions or reasons for subject choice. The survey will take approximately 15 minutes and be designed to be completed outside of school although schools may choose to make time within school hours to complete the survey (this is not required). Students in year 10 will be invited to re-enter the survey after they have made their subject choice to provide information on what they chose.

Schools will be provided with results from the study.

The following figure provides an outline of the timetable for this study showing proposed completion in March 2015.

FIGURE 3: TIMETABLE FOR STUDY.



The timing of each stage will be negotiated with the schools.

CONCLUSION

This paper outlines some key facets of Fresh Minds for Science and I invite you to visit my website at www.freshmindsforscience.weebly.com to find out more about the other research in this area and the theoretical framework that underpins this work. This research aims to provide important information to address a matter of national priority; concerns over the future supply of people trained in science and related fields. The approach investigates how decisions are made regarding subject choice and what will influence these decisions. The subjects students choose to study in their final years of schooling have a major influence on the career and educational options open to them (Thomson, 2005; Ainley, Kos, & Nicholas, 2008). This research will contribute to educational research by creating new insights into student behaviour.

Your school can help me to investigate how student choose their subjects and what influences their decision to choose science. Your school will share in the results of this study and your students will benefit by seeing the research process first hand. In addition, I am happy to make myself available to talk to students about research and science.

Please consider information in the "University of Technology Sydney Plain English Statement and Consent Form" as it clearly states what your school is committing to and that the school and participants are free to leave the study without reason at any time. *Please complete this form if you wish to participate.* Should you wish to see the UTS Ethics application or *SE*RAP Ethics application, please ask and I will be delighted to provide these documents.

Thank you for your consideration, I hope you will join me in investigating the important issue of student's participation in science.

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Document B.2: School process cheat sheet

School process cheat sheet

What I need from you…

The signed consent form for the school

Students to participate in focus groups:

- 2 x 6 year 10s
- 2 x 6 year 11s

Ideally these groups will be made up of year 10 students who are performing well in science.

Groups of year 11 students made up of 3 science (chemistry or physics if possible) and 3 non-science students seemed likely students of science but didn't take it. Students who teachers were surprised did not take science would be perfect.

Then…

Students (and parents) participating in the focus groups will need to

- Complete the consent form
- Come to a focus group (35-40 minutes plus set up time, say 50 minutes total)

Timing of focus groups is at your convenience as soon as practicable.

I also need to understand the environment within which subject decisions are made. To do this I need:

- Access to the information students in year 10 are given and told to inform their subject (or career) decisions.
- Access to teachers/heads of departments/careers advisers or whomever you feel plays a direct role in helping students choose subjects.

Document B.3: Adult consent

Faculty of Arts and Social Sciences: Education

PO Box 222
Lindfield, NSW, 2070
University of Technology Sydney
Australia

Tel: 61 2 9514 5621
Fax: 61 2 9514 5556

I _____ (participant's name) agree to participate in the research project "Fresh Minds for Science: using marketing science to help school science" being conducted by Tracey-Ann Palmer BSc(Hons) MBA BTeach (phone 0401 801 031) of the University of Technology Sydney for her doctor of philosophy degree.

I understand that the purpose of this study is to look why and how students choose science as an elective at school.

I understand that I have been asked to participate in this research because I interact with students to help them to make decisions about choosing subjects at school. I will be participating in an interview but my responses will be anonymous. I will not be identified either directly or by implication when the research is published.

I am aware that I can contact Tracey-Ann Palmer or her supervisor Peter Aubusson (02) 9514 5264 if I have any concerns about the research. I also understand that I am free to withdraw my participation from this research project at any time I wish, without consequences, and without giving a reason.

I agree that Tracey-Ann Palmer has answered all my questions fully and clearly.

I agree that the research data gathered from this project may be published in a form that does not identify me in any way.

_____ ____/____/____

Signature (*participant*)

PhD website: www.freshmindsforscience.weebly.com

Document B.4: Student consent

Faculty of Arts and Social Sciences: Education

PO Box 222
Lindfield, NSW, 2070
University of Technology Sydney
Australia

Tel: 61 2 9514 5621
Fax: 61 2 9514 5556

I _____ (participant's name) agree to participate in the research project Fresh Minds for Science: using marketing science to help school science being conducted by Tracey-Ann Palmer BSc(Hons) MBA BTeach (phone 0401 801 031) of the University of Technology Sydney for her doctor of philosophy degree.

I understand that the purpose of this study is to look why and how students choose science as an elective at school.

I understand that I have been asked to participate in this research because I am about to, or have already made a decision about choosing my elective subjects at school and that my participation will involve contributing to an on-line focus group with some other students from my school. I will be in a room with the other students but I won't know who is making individual comments in the group because the conversation will be held on-line.

I am aware that I can contact Tracey-Ann Palmer or her supervisor Peter Aubusson (02) 9514 5264 if I have any concerns about the research. I also understand that I am free to withdraw my participation from this research project at any time I wish, without consequences, and without giving a reason.

I agree that Tracey-Ann Palmer has answered all my questions fully and clearly.

I agree that the research data gathered from this project may be published in a form that does not identify me in any way.

_____ ____/____/____
Signature (*participant*)

I _____ (*parent/guardian's name*) am the parent/guardian of the above participant and I have read the information above and agree for them to participate in the study.

_____ ____/____/____
Signature (*parent/guardian*)

Document B.5: Adult interview fact sheet

INFORMATION SHEET – INTERVIEWS

FRESH MINDS FOR SCIENCE
USING MARKETING SCIENCE TO HELP SCHOOL SCIENCE
(UTS APPROVAL NUMBER: 2012-392)

WHO IS DOING THE RE*SE*ARCH?
My name is Tracey-Ann Palmer and I am a PhD student at the University of Technology Sydney
(My supervisor is Peter Aubusson).

WHAT IS THIS RE*SE*ARCH ABOUT?
This research is to find out how students choose science as a subject at school. I am interested in finding out how students made a decision either to, or not to, study science as an elective.

IF I SAY YES, WHAT WILL IT INVOLVE?
I will ask you to participate in a semi-structured interview and have this interview recorded and transcribed.

ARE THERE ANY RISKS/INCONVENIENCE?
Yes, you will need to give up some free time to speak to me.

WHY HAVE I BEEN ASKED?
You are able to give me the information about how you believe students choose elective subjects at school and help me understand this process as it relates to Science subjects. I want to know your opinions on this process and gather information on your experiences.

DO I HAVE TO SAY YES?
You don't have to say yes.

WHAT WILL HAPPEN IF I SAY NO?
Nothing. I will thank you for your time so far and won't contact you about this research again.

IF I SAY YES, CAN I CHANGE MY MIND LATER?
You can change your mind at any time and you don't have to say why. I will thank you for your time so far and won't contact you about this research again.

WHAT IF I HAVE CONCERNS OR A COMPLAINT?
If you have concerns about the research that you think I or my supervisor can help you with, please feel free to contact me (Tracey-Ann Palmer) on 0401 801 031 or my supervisor, Peter Aubusson, on (02) 9514 5264.

If you would like to talk to someone who is not connected with the research, you may contact
Ms. Racheal Laugery, Research Ethics Officer
Research & Innovation Office, University of Technology, Sydney
Phone: (02) 9514 9772: Fax: (02) 9514 1244
Generic: Research.Ethics@uts.edu.au: Direct: Racheal.Laugery@uts.edu.au
Web: http://www.research.uts.edu.au/policies/restricted/ethics.html
Post: PO Box 123, BROADWAY NSW 2007
Location: Level 14, Building 1, Broadway Campus
Please quote this number (UTS HREC 2012-392)

Document B.6: Focus group fact sheet

INFORMATION SHEET

FRESH MINDS FOR SCIENCE
USING MARKETING SCIENCE TO HELP SCHOOL SCIENCE
(UTS APPROVAL NUMBER: UTS HREC 2012000392)

WHO IS DOING THE RE*SE*ARCH?
My name is Tracey-Ann Palmer and I am a PhD student at the University of Technology Sydney
(My supervisor is Peter Aubusson).

WHAT IS THIS RE*SE*ARCH ABOUT?
The purpose of this study is to improve the science learning experience of children in year 8 at school.

IF I SAY YES, WHAT WILL IT INVOLVE?
I may be asked to join focus groups, participate in interviews and fill in surveys about my experiences in this study.

ARE THERE ANY RISKS/INCONVENIENCE?
Yes, you will need to miss out on some of your lunchtime to participate in the research but I hope you will enjoy contributing to this research and to reward you for your time we would like to give you

WHY HAVE I BEEN ASKED?
You are able to give me the information about your own experiences with science in the year 8 classroom.

DO I HAVE TO SAY YES?
You don't have to say yes.

WHAT WILL HAPPEN IF I SAY NO?
Nothing. I will thank you for your time so far and won't contact you about this research again.

IF I SAY YES, CAN I CHANGE MY MIND LATER?
You can change your mind at any time and you don't have to say why. I will thank you for your time so far and won't contact you about this research again.

WHAT IF I HAVE CONCERNS OR A COMPLAINT?
If you have concerns about the research that you think I or my supervisor can help you with, please feel free to contact me (Tracey-Ann Palmer) on 0401 801 031 or my supervisor, Peter Aubusson, on (02) 9514 5264.

If you would like to talk to someone who is not connected with the research, you may contact the Research Ethics Officer on 02 9514 9772, and quote this number *(UTS HREC 2012000392)*

Appendix C: Fresh Minds for Science Survey

Survey 1 is the BWS-Accept version

Survey 2 is the BWS-Reject version

This survey has been converted to pdf format from the online version for publishing in this thesis. The text is identical to that presented to the students. The formatting, however, has been modified to fit these pages.

Welcome to Fresh Minds for Science
SURVEY 1

About this research...
My name is Tracey-Ann Palmer and I am a PhD student at the University of Technology Sydney (My supervisor is Peter Aubusson). This research is to find out how you chose your subjects at school. Although I am interested in science this survey is to find out how you chose **all** your subjects.

You can help me by giving me information about choosing your subjects for year 11. You don't have to complete this survey and can leave it at any time. It will take about 15 minutes and your answers will be completely anonymous.

If you have any questions or complaints...
Call me (Tracey-Ann Palmer) on 0401 801 031 or my supervisor, Peter Aubusson, on (02) 9514 5264 .
If you would like to talk to someone who is not connected with the research, call:
Ms. Racheal Laugery, Research Ethics Officer, Research & Innovation Office, University of Technology, Sydney
Phone: (02) 9514 9772: Fax: (02) 9514 1244
General email address: Research.Ethics@uts.edu.au, Direct email address: Racheal.Laugery@uts.edu.au
Please quote this number (UTS HREC 2012-392)

I have read the above consent form and wish to participate in this study.

○ I AGREE

This section tells me a bit about you.

How old are you?

○ 14
○ 15
○ 16
○ 17

What is your school year?

☐ Year 10
☐ Year 11

What is your gender?

○ Male

◯ Female

What type of school do you go to?

How sure are you about what you will study or choose as a career after you leave school?

No idea	A vague idea	Some idea	Pretty sure	Absolutely sure
◯	◯	◯	◯	◯

If you have an idea what you will do after school please let me know what you have planned?

How difficult was it to...

	Very Difficult	Difficult	Neutral	Easy	Very Easy
Choose the subjects you wanted to do?	◯	◯	◯	◯	◯
Choose subjects you did not want to do?	◯	◯	◯	◯	◯
Find out information about the subjects?	◯	◯	◯	◯	◯
Make your final subject selection?	◯	◯	◯	◯	◯

This section is in four parts, each with 5 or 6 questions.

Please think about how you chose your subjects for year 11. For each of the sets of features below, please select the feature that you find ***most*** important AND ***least*** important in choosing a subject to study.

So, in the example below, if you thought the fact that you enjoyed the subject in middle school was the most important feature listed, you would click the button under 'most important' for that factor. If you found the type of assessment the least important factor listed, you would click the button next to that sentence under 'least important'.

Here is what your answer would look like...

EXAMPLE ONLY

Most important		Least important
○	I think the subject's teachers can help me get a good mark	○
○	A friend in my year suggested doing the subject	○
◉	I enjoyed the subject (or a similar subject in middle school	○
○	I like the type of assessment	◉
○	I had plenty of information about the subject	○

Here we go... tell me your ***most*** and ***least*** important factors in choosing a subject for year 11 from each list.

Part 1 of 4 parts

Question 1.1

Most important		Least important
○	Older students or sibling suggested doing the subject	○
○	I received good marks in this subject (or a similar subject) in middle school	○
○	I enjoyed the subject (or similar subject) in middle school	○
○	I like a teacher or teachers I might get	○
○	I will enjoy the classwork for this subject	○

Question 1.2

Most important		Least important
○	I had plenty of information about the subject	○
○	I needed extra units	○
○	My parent(s) suggested doing the subject	○
○	I enjoyed the subject (or similar subject) in middle school	○

○	The subject fitted with my timetable	○

Question 1.3

Most important		Least important
○	I enjoyed the subject (or similar subject) in middle school	○
○	The subject will scale well for my ATAR	○
○	A friend in my year suggested doing the subject	○
○	The subject could be useful for my career	○
○	I think the subjects teachers can help me get a good mark	○

Question 1.4

Most important		Least important
○	I enjoyed the subject (or similar subject) in middle school	○
○	The subject will be useful in my personal life	○
○	I like the type of assessment	○
○	I will find the subject interesting	○
○	I find the subject easy compared to other subjects	○

Question 1.5

Most important		Least important
○	I like how the subject is taught	○
○	I probably need the subject for my future study	○
○	I think I can get good marks in the subject	○
○	I enjoyed the subject (or similar subject) in middle school	○
○	My teacher suggested doing the subject	○

And the next set ... tell me your ***most*** and ***least*** important factors in choosing a subject for year 11 from each list.

Part 2 of 4 parts

Question 2.1

Most important		Least important
○	I will find the subject interesting	○
○	A friend in my year suggested doing the subject	○
○	My parent(s) suggested doing the subject	○
○	Older students or sibling suggested doing the subject	○
○	My teacher suggested doing the subject	○

Question 2.2

Most important		Least important
○	I probably need the subject for my future study	○
○	I needed extra units	○
○	Older students or sibling suggested doing the subject	○
○	The subject will scale well for my ATAR	○
○	I will find the subject easy compared to other subjects	○

Question 2.3

Most important		Least important
○	The subject could be useful for my career	○
○	I like how the subject is taught	○
○	Older students or sibling suggested doing the subject	○
○	I had plenty of information about the subject	○
○	I like the type of assessment	○

Question 2.4

Most important		Least important
○	The subject fitted with my timetable	○
○	I think I can get good marks in the subject	○

○	Older students or sibling suggested doing the subject	○
○	I think the subject's teachers can help me get a good mark	○
○	The subject will be useful in my personal life	○

Question 2.5

Most important		Least important
○	My parent(s) suggested doing the subject	○
○	I think I can get good marks in the subject	○
○	I like the type of assessment	○
○	I received good marks in the subject (or similar subject) in middle school	○
○	The subject will scale well for my ATAR	○

And the next set... tell me your ***most*** and ***least*** important factors in choosing a subject for year 11 from each list.

Part 3 of 4 parts

Question 3.1

Most important		Least important
○	The subject will be useful in my personal life	○
○	I needed extra units	○
○	A friend in my year suggested doing the subject	○
○	I like how the subject is taught	○
○	I received good marks in the subject (or similar subject) in middle school	○

Question 3.2

Most important		Least important
○	I think the subject's teachers can help me get a good mark	○
○	I received good marks in a similar subject in middle school	○
○	I had plenty of information about the subject	○
	I will find the subject	

○	interesting	○
○	I probably need the subject for my future study	○

Question 3.3

Most important		Least important
○	The subject could be useful for my career	○
○	The subject fitted with my timetable	○
○	My teacher suggested doing the subject	○
○	I received good marks in the subject (or similar subject) in middle school	○
○	I will find the subject easy compared to other subjects	○

Question 3.4

Most important		Least important
○	My parent(s) suggested doing the subject	○
○	The subject could be useful for my career	○
○	I probably need the subject for my future study	○
○	The subject will be useful in my personal life	○
○	I like a teacher or teachers I might get	○

Question 3.5

Most important		Least important
○	My teacher suggested doing the subject	○
○	I like the type of assessment	○
○	I needed extra units	○
○	I like a teacher or teachers I might get	○
○	I think the subject's teachers can help me get a good mark	○

And the last set (well done!) ... tell me your ***most*** and ***least*** important factors in choosing a subject for year 11 from each list.

Part 4 of 4 parts

Question 4.1

Most important		Least important
○	I like a teacher or teachers I might get	○
○	I will find the subject easy compared to other subjects	○
○	I think I can get good marks in the subject	○
○	I had plenty of information about the subject	○
○	A friend in my year suggested doing the subject	○

Question 4.2

Most important		Least important
○	I like how the subject is taught	○
○	The subject fitted with my timetable	○
○	The subject will scale well for my ATAR	○
○	I like a teacher or teachers I might get	○
○	I will find the subject interesting	○

Question 4.3

Most important		Least important
○	My parent(s) suggested doing the subject	○
○	I think the subject's teachers can help me get a good mark	○
○	I will enjoy the classwork for this subject	○
○	I like how the subject is taught	○
○	I will find the subject easy compared to other subjects	○

Question 4.4

Most important		Least important
○	The subject could be useful for my career	○
○	I needed extra units	○

○	I think I can get good marks in the subject	○
○	I will enjoy the classwork for this subject	○
○	I will find the subject interesting	○

Question 4.5

Most important		Least important
○	The subject will scale well for my ATAR	○
○	I will enjoy the classwork for this subject	○
○	I had plenty of information about the subject	○
○	My teacher suggested doing the subject	○
○	The subject will be useful in my personal life	○

Question 4.6

Most important		Least important
○	The subject fitted with my timetable	○
○	I probably need the subject for my future study	○
○	A friend in my year suggested doing the subject	○
○	I will enjoy the classwork for this subject	○
○	I like the type of assessment	○

Did you choose to study science for year 11?

- ○ Yes
- ○ No

What science subject(s) did you choose?

- ☐ Biology
- ☐ Chemistry
- ☐ Physics
- ☐ Senior Science
- ☐ Earth and Environmental Science
- ☐

Other (please write the subject(s) here

Why did you choose to study a science in year 11?

Why didn't you choose to study a science in year 11?

If there anything important that helped you choose your subjects that hasn't been mentioned in this survey, can you tell me about it here?

Do you have some advice for me on how to encourage more students to study science for year 11?

Thank you
I hope you enjoy your subject choices!
Tracey-Ann

Welcome to Fresh Minds for Science
SURVEY 2

About this research...
My name is Tracey-Ann Palmer and I am a PhD student at the University of Technology Sydney (My supervisor is Peter Aubusson). This research is to find out how you chose your subjects at school. Although I am interested in science this survey is to find out how you chose **all** your subjects.

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If you would like to talk to someone who is not connected with the research, call:
Ms. Racheal Laugery, Research Ethics Officer, Research & Innovation Office, University of Technology, Sydney
Phone: (02) 9514 9772: Fax: (02) 9514 1244
General email address: Research.Ethics@uts.edu.au, Direct email address: Racheal.Laugery@uts.edu.au

Please quote this number (UTS HREC 2012-392)

I have read the above consent form and wish to participate in this study.

- ○ I AGREE

This section tells me a bit about you.

How old are you?

- ○ 14
- ○ 15
- ○ 16
- ○ 17

What is your school year?

- ☐ Year 10
- ☐ Year 11

What is your gender?

- ○ Male
- ○ Female

What type of school do you go to?

How sure are you about what you will study or choose as a career after you leave school?

No idea	A vague idea	Some idea	Pretty sure	Absolutely sure
○	○	○	○	○

If you have an idea what you will do after school please let me know what you have planned?

How difficult was it to...

	Very Difficult	Difficult	Neutral	Easy	Very Easy
Choose the subjects you wanted to do?	○	○	○	○	○
Choose subjects you didn't want to do?	○	○	○	○	○
Find out information about the subjects?	○	○	○	○	○
Make your final subject selection?	○	○	○	○	○

This section is in four parts, each with 5 or 6 questions.

Please think about how you chose your subjects for year 11. For each of the sets of features below, please select the feature that you find ***most*** important AND ***least*** important in REJECTING a subject to study.

So, in the example below, if you thought the fact that you did not enjoy the subject in middle school was the most important feature listed in not choosing a subject, you would click the button under 'most important' for that factor. If you found the type of assessment the least important factor listed, you would click the button next to that sentence under 'least important'.

Here is what your answer would look like...

EXAMPLE ONLY

Most important		Least important
○	I don't think the subject's teachers can help me get a good mark	○
○	A friend in my year suggested not doing the subject	○
◉	I did not enjoy the subject (or a similar subject) in middle school	○
○	I do not like the type of assessment	◉
○	I did not have enough information about the subject	○

Here we go... tell me your ***most*** and ***least*** important factors in REJECTING a subject for year 11 from each list.

Part 1 of 4 parts

Question 1.1

Most important		Least important
○	Older students or sibling suggested not doing the subject	○
○	I won't enjoy the classwork for this subject	○
○	I dislike a teacher or teachers I might get	○
○	I did not enjoyed the subject (or similar subject) in middle school	○
○	I received poor marks in this subject (or a similar subject) in middle school	○

Question 1.2

Most important		Least important
○	I did not enjoy the subject (or similar subject) in middle school	○
○	My parent(s) suggested not doing the subject	○
○	I had too many units	○
○	I did not have enough information about the subject	○
○	The subject did not fit my timetable	○

Question 1.3

Most important		Least important
○	I did not enjoy the subject (or similar subject) in middle school	○
○	The subject will not scale well for my ATAR	○
○	The subject is unlikely to be useful for my career	○
○	I don't think the subjects teachers can help me get a good mark	○
○	A friend in my year suggested not doing the subject	○

Question 1.4

Most important		Least important

○	I do not like the type of assessment	○
○	I will find the subject hard compared to other subjects	○
○	I did not enjoy the subject (or similar subject) in middle school	○
○	I will find the subject boring	○
○	The subject will not be useful in my personal life	○

Question 1.5

Most important		Least important
○	I did not enjoy the subject (or similar subject) in middle school	○
○	I think it will be hard to get good marks in the subject	○
○	I do not like how the subject is taught	○
○	My teacher suggested not doing the subject	○
○	I probably won't need the subject for my future study	○

And the next set ... tell me your ***most*** and ***least*** important factors in REJECTING a subject for year 11 from each list.

Part 2 of 4 parts

Question 2.1

Most important		Least important
○	I will find the subject boring	○
○	My parent(s) suggested not doing the subject	○
○	Older students or sibling suggested not doing the subject	○
○	A friend in my year suggested not doing the subject	○
○	My teacher suggested not doing the subject	○

Question 2.2

Most important		Least important
○	I probably won't need the subject for my future study	○

○	The subject will not scale well for my ATAR	○
○	Older students or sibling suggested not doing the subject	○
○	I will find the subject hard compared to other subjects	○
○	I had too many units	○

Question 2.3

Most important		Least important
○	I do not like how the subject is taught	○
○	I did not have enough information about the subject	○
○	I do not like the type of assessment	○
○	The subject is unlikely to be useful for my career	○
○	Older students or sibling suggested not doing the subject	○

Question 2.4

Most important		Least important
○	The subject did not fit with my timetable	○
○	The subject will not be useful in my personal life	○
○	Older students or sibling suggested not doing the subject	○
○	I don't think the subject's teachers can help me get a good mark	○
○	I think it will be hard to get good marks in the subject	○

Question 2.5

Most important		Least important
○	I received poor marks in the subject (or similar subject) in middle school	○
○	I do not like the type of assessment	○
○	My parent(s) suggested not doing the subject	○
○	The subject will not scale well for my ATAR	○

○	I think it will be hard to get good marks in the subject	○

And the next set... tell me your ***most*** and ***least*** important factors in REJECTING a subject for year 11 from each list.

Part 3 of 4 parts

Question 3.1

Most important		Least important
○	I had too many units	○
○	The subject will not be useful in my personal life	○
○	I received poor marks in the subject (or similar subject) in middle school	○
○	I do not like like how the subject is taught	○
○	A friend in my year suggested not doing the subject	○

Question 3.2

Most important		Least important
○	I did not have enough information about the subject	○
○	I will find the subject boring	○
○	I received poor marks in a similar subject in middle school	○
○	I don't think the subject's teachers can help me get a good mark	○
○	I probably won't need the subject for my future study	○

Question 3.3

Most important		Least important
○	My teacher suggested not doing the subject	○
○	The subject is unlikely to be useful for my career	○
○	The subject did not fit with my timetable	○
○	I will find the subject hard compared to other subjects	○
○	I received poor marks in the subject (or similar subject) in middle school	○

Question 3.4

Most important		Least important
○	The subject will not be useful for my career	○
○	The subject is unlikely to be useful in my personal life	○
○	I dislike a teacher or teachers I might get	○
○	I probably won't need the subject for my future study	○
○	My parent(s) suggested not doing the subject	○

Question 3.5

Most important		Least important
○	My teacher suggested not doing the subject	○
○	I had too many units	○
○	I dislike a teacher or teachers I might get	○
○	I do not like the type of assessment	○
○	I don't think the subject's teachers can help me get a good mark	○

And the last set (well done!) ... tell me your ***most*** and ***least*** important factors in REJECTING a subject for year 11 from each list.

Part 4 of 4 parts

Question 4.1

Most important		Least important
○	A friend in my year suggested not doing the subject	○
○	I think it will be hard to get good marks in the subject	○
○	I did not have enough information about the subject	○
○	I dislike a teacher or teachers I might get	○
○	I will find the subject hard compared to other subjects	○

Question 4.2

Most important		Least important
○	The subject does not fit with my timetable	○
○	I do not like how the subject is taught	○
○	I will find the subject boring	○
○	The subject will not scale well for my ATAR	○
○	I dislike a teacher or teachers I might get	○

Question 4.3

Most important		Least important
○	I will find the subject hard compared to other subjects	○
○	I don't think the subject's teachers can help me get a good mark	○
○	I won't enjoy the classwork for this subject	○
○	My parent(s) suggested not doing the subject	○
○	I do not like how the subject is taught	○

Question 4.4

Most important		Least important
○	I will find the subject boring	○
○	The subject is unlikely to be useful for my career	○
○	I think it will be hard to get good marks in the subject	○
○	I won't enjoy the classwork for this subject	○
○	I had too many units	○

Question 4.5

Most important		Least important
○	I did not have enough information about the subject	○
○	My teacher suggested not doing the subject	○
○	The subject will not be useful in my personal life	○

○	The subject will not scale well for my ATAR	○
○	I won't enjoy the classwork for this subject	○

Question 4.6

Most important		Least important
○	A friend in my year suggested not doing the subject	○
○	I probably won't need the subject for my future study	○
○	I do not like the type of assessment	○
○	I won't enjoy the classwork for this subject	○
○	The subject did not fit with my timetable	○

Did you choose to study science for year 11?

- ○ Yes
- ○ No

What science subject(s) did you choose?

- ☐ Biology
- ☐ Chemistry
- ☐ Physics
- ☐ Senior Science
- ☐ Earth and Environmental Science
- ☐ Other (please write the subject(s) here

Why did you choose a science for year 11?

If you didn't you choose a science for year 11 please tell me why?

If there anything important that helped you choose your subjects that hasn't been mentioned in this survey, can you tell me about it here?

Do you have some advice for me on how to encourage more students to study science for year 11?

Thank you
I hope you enjoy your subject choices!
Tracey-Ann

Appendix D: Best Worst Scaling gender and Science choice data

The BWS Survey data is presented in this Appendix. The tables in this appendix show descriptive statistics (mean, standard deviation, standard error, and sample size) for each of the factors and inferential statistical analysis using using *t*-tests that were two sample, two tailed, and assumed unequal variances.

For presentation purposes, the six tables are in three pairs with the first table presenting data for factors 1 - 11 and the second presenting data for factors 12 - 21. Tables D.1 and D.2 show descriptive statistics for BWS-Accept and BWS-Reject scores for male and female students and inferential statistics comparing these scores (labelled Male v Female). Table D.3 and Table D.4 show descriptive statistics for BWS-Accept and BWS-Reject scores for students who chose science (labelled "Science" and did not choose Science (labelled No Science) and inferential statistics comparing the scores of Science and No Science students (labelled Science v No Science).

Table D. 1: Descriptive and inferential statistics for BWS-Accept and BWS-Reject scores for Factors 1 - 11 by gender

	Factor										
Statistic	1	2	3	4	5	6	7	8	9	10	11
BWS-Accept score Males											
Mean (*M*)	-0.55	-1.04	-1.91	-0.53	2.33	0.99	-1.95	-2.15	0.00	0.97	-0.01
Standard deviation (*SD*)	1.41	1.63	1.59	1.58	1.82	1.70	1.88	1.88	1.43	1.64	1.92
Standard error (*SE*)	0.15	0.17	0.17	0.16	0.19	0.18	0.20	0.20	0.15	0.17	0.20
Sample size (n)	93	93	93	93	93	93	93	93	93	93	93
BWS-Accept score Females											
Mean (*M*)	-1.08	-1.58	-2.67	-0.73	2.89	1.98	-2.39	-2.59	-0.34	1.64	-0.13
Standard deviation (*SD*)	1.68	1.42	1.60	1.37	1.63	1.33	1.48	1.52	1.25	1.59	2.19
Standard error (*SE*)	0.21	0.18	0.21	0.17	0.20	0.17	0.18	0.19	0.16	0.20	0.27
Sample size (n)	64	64	64	64	64	64	64	64	64	64	64
BWS-Accept Male v Female											
Degrees of freedom (*DF*)	119	146	135	147	144	153	152	151	146	139	124
t – value (*t*)	2.07	2.18	2.92	0.88	-2.00	-4.11	1.65	1.63	1.60	-2.57	0.34
p – value (*p*)	.0409	.0307	.0041	.3827	.0469	.0001	.1003	.1057	.1126	.0112	.7360
BWS-Reject score Males											
Mean (*M*)	-0.17	-0.55	-1.49	-0.08	1.06	1.28	-0.30	-1.47	-0.35	0.38	-0.13
Standard Deviation (*SD*)	1.55	1.60	1.69	1.57	2.18	2.10	2.27	1.99	1.54	1.75	2.19
Standard error (*SE*)	0.16	0.17	0.18	0.17	0.23	0.22	0.24	0.21	0.16	0.19	0.23
Sample size (n)	89	89	89	89	89	89	89	89	89	89	89
BWS-Reject score Females											
Mean (*M*)	-0.84	-1.02	-2.74	-0.06	1.21	1.94	0.11	-0.76	-0.56	1.55	0.21
Standard deviation (*SD*)	1.87	1.85	1.83	1.84	2.45	1.88	2.07	1.93	1.74	1.82	2.41
Standard error (*SE*)	0.20	0.20	0.20	0.20	0.26	0.20	0.22	0.21	0.19	0.19	0.26
Sample size (n)	87	87	87	87	87	87	87	87	87	87	87
BWS Reject Male v Female											
Degrees of freedom (*DF*)	167	169	172	169	171	173	173	174	170	173	172
t – value (*t*)	2.59	1.81	4.66	-0.08	-0.43	-2.21	-1.28	-2.42	0.87	-4.34	-0.98
p – value (*p*)	.0105	.0721	.0000	.9346	.6673	.0287	.2023	.0168	.3875	.0000	.3269

Table D. 2: Descriptive and inferential statistics for BWS-Accept and BWS-Reject scores for Factors 12 -21 by gender

	Factor									
Statistic	12	13	14	15	16	17	18	19	20	21
BWS-Accept score Males										
Mean (*M*)	1.59	-0.66	0.95	0.18	-0.22	-0.56	-0.88	1.26	0.22	1.97
Standard deviation (*SD*)	1.73	1.53	1.90	1.78	1.63	1.62	1.68	1.83	1.98	2.16
Standard error (*SE*)	0.18	0.16	0.20	0.18	0.17	0.17	0.17	0.19	0.21	0.22
Sample size (n)	93	93	93	93	93	93	93	93	93	93
BWS-Accept score Female										
Mean (*M*)	1.97	-1.02	1.55	0.08	-0.23	-0.20	-1.02	1.83	-0.39	2.44
Standard Deviation (*SD*)	1.51	1.69	1.41	1.66	1.59	1.35	1.54	1.91	2.03	1.83
Standard error (*SE*)	0.14	0.14	0.13	0.13	0.13	0.12	0.16	0.16	0.17	0.17
Sample size (n)	64	64	64	64	64	64	64	64	64	64
BWS-Accept Male v Female										
Degrees of freedom (*DF*)	146	126	154	141	138	149	143	132	134	148
t – value (*t*)	-1.45	1.36	-2.27	0.38	0.07	-1.50	0.52	-1.87	1.86	-1.47
p – value (*p*)	.1494	.1764	.0245	.7069	.9412	.1364	.6065	.0635	.0657	.1447
BWS-Reject score Males										
Mean (*M*)	0.75	-0.54	0.57	-0.06	0.11	-0.07	-0.31	0.65	-0.21	0.93
Standard deviation (*SD*)	1.80	1.67	1.66	1.39	1.53	1.80	1.97	1.87	2.04	2.25
Standard error (*SE*)	0.19	0.18	0.18	0.15	0.16	0.19	0.21	0.22	0.20	0.24
Sample size (n)	89	89	89	89	89	89	89	89	89	89
BWS-Reject score Female										
Mean (*M*)	1.24	-0.67	1.03	0.52	-0.40	-0.16	-0.63	0.23	-0.74	0.53
Standard deviation (*SD*)	1.74	1.74	1.60	1.63	1.55	1.53	2.17	1.80	2.12	1.96
Standard error (*SE*)	0.19	0.21	0.18	0.21	0.20	0.17	0.19	0.24	0.25	0.23
Sample size (n)	87	87	87	87	87	87	87	87	87	87
BWS-Reject Male v Female										
Degrees of freedom (*DF*)	174	173	174	168	174	168	174	171	171	174
t – value (*t*)	-1.83	0.50	-1.87	-2.50	-1.87	-2.50	2.21	0.37	1.02	1.53
p – value (*p*)	.0686	.6210	.0626	.0133	.0626	.0133	.0282	.7109	.3114	.1289

Table D. 3: Descriptive statistics for BWS-Accept verses BWS-Reject for factors 1 - 11 for Science and No Science respondents

	Factor										
Statistic	1	2	3	4	5	6	7	8	9	10	11
BWS-Accept Science											
Mean (*M*)	-0.77	-1.26	-2.15	-0.72	2.47	1.45	-2.13	-2.29	-0.14	1.26	-0.24
Standard deviation (*SD*)	1.64	1.68	1.67	1.55	1.86	1.55	1.57	1.80	1.34	1.65	2.05
Standard error (*SE*)	0.17	0.17	0.17	0.16	0.19	0.16	0.16	0.19	0.14	0.17	0.21
Sample size (n)	94	94	94	94	94	94	94	94	94	94	94
BWS-Accept No Science											
Mean (*M*)	-0.38	-0.74	-2.25	0.12	1.28	1.59	-0.12	-1.13	-0.38	1.03	-0.15
Standard deviation (*SD*)	1.67	1.76	1.78	1.79	2.28	2.08	2.26	1.99	1.59	1.93	2.12
Standard error (*SE*)	0.15	0.16	0.16	0.17	0.21	0.19	0.21	0.18	0.15	0.18	0.20
Sample size (n)	117	117	117	117	117	117	117	117	117	117	117
BWS-Accept Science v No Science											
Degrees of freedom (*DF*)	148	148	137	141	145	121	112	139	128	132	137
t – value (*t*)	-2.00	0.06	0.70	-1.17	-0.82	0.47	0.00	0.39	0.02	0.12	-1.43
p – value (*p*)	.0477	.9531	.4869	.2451	.4111	.6367	.9982	.6986	.9839	.9027	.1547
BWS-Accept No Science											
Mean (*M*)	-0.76	-1.27	-2.33	-0.44	2.70	1.32	-2.13	-2.40	-0.14	1.22	0.22
Standard deviation (*SD*)	1.40	1.39	1.60	1.41	1.61	1.76	1.98	1.69	1.41	1.67	1.97
Standard error (*SE*)	0.18	0.18	0.20	0.18	0.20	0.22	0.25	0.21	0.18	0.21	0.25
Sample size (n)	63	63	63	63	63	63	63	63	63	63	63
BWS-Reject No Science											
Mean (*M*)	-0.67	-0.90	-1.81	-0.47	0.84	1.69	-0.12	-1.10	-0.60	0.81	0.33
Standard deviation (*SD*)	1.85	1.71	2.03	1.45	2.38	1.88	1.97	2.01	1.77	1.78	2.58
Standard error (*SE*)	0.24	0.23	0.27	0.19	0.31	0.25	0.26	0.26	0.23	0.23	0.24
Sample size (n)	58	58	58	58	58	58	58	58	58	58	58
BWS-Reject Science v No Science											
Degrees of freedom (*DF*)	104	117	101	137	109	125	129	112	104	122	96
t – value (*t*)	1.00	0.58	-1.40	2.32	1.16	-0.32	0.00	-0.08	0.80	0.76	-1.21
p – value (t)	.3190	.5622	.1653	.0221	.2491	.7497	.9975	.9389	.4270	.4482	.2307

Table D. 4: Descriptive statistics for BWS-Accept verses BWS-Reject for factors 12 - 21 for Science and No Science respondents

	Factor									
Statistic	12	13	14	15	16	17	18	19	20	21
BWS-Accept Science										
Mean (*M*)	1.61	-0.81	1.03	0.30	-0.33	-0.26	-0.80	1.63	-0.16	2.31
Standard deviation (*SD*)	1.62	1.57	1.73	1.84	1.66	1.47	1.58	1.84	1.93	2.04
Standard error (*SE*)	0.17	0.16	0.18	0.19	0.17	0.15	0.16	0.19	0.20	0.21
Sample size (n)	94	94	94	94	94	94	94	94	94	94
BWS-Accept No Science										
Mean (*M*)	1.95	-0.79	1.43	-0.10	-0.06	-0.65	-1.14	1.29	0.16	1.94
Standard deviation (*SD*)	1.68	1.67	1.73	1.53	1.54	1.57	1.66	1.93	2.14	2.03
Standard error (*SE*)	0.17	0.15	0.15	0.14	0.13	0.15	0.17	0.16	0.19	0.20
Sample size (n)	63	63	63	63	63	63	63	63	63	63
BWS-Accept Science v No Science										
Degrees of freedom (*DF*)	130	127	133	148	139	127	129	129	123	134
t – value (*t*)	-1.28	-0.06	-1.41	1.45	-1.03	1.59	1.30	1.11	-0.95	1.12
p – value (*p*)	.2018	.9554	.1615	.1481	.3053	.1150	.1966	.2694	.3444	.2637
BWS-Reject Science										
Mean (*M*)	1.09	-0.50	0.94	0.18	-0.22	-0.17	-0.49	0.34	-0.69	0.63
Standard deviation (*SD*)	1.75	1.71	1.71	1.56	1.64	1.72	2.14	1.93	2.08	2.03
Standard error (*SE*)	0.16	0.16	0.16	0.14	0.15	0.16	0.20	0.18	0.19	0.19
Sample size (n)	117	117	117	117	117	117	117	117	117	117
BWS-Reject No Science										
Mean (*M*)	0.81	-0.86	0.55	0.31	-0.05	-0.02	-0.48	0.69	0.05	1.00
Standard deviation (*SD*)	1.85	1.65	1.48	1.51	1.30	1.58	1.93	1.64	1.97	2.24
Standard error (*SE*)	0.21	0.21	0.22	0.19	0.19	0.20	0.21	0.24	0.27	0.26
Sample size (n)	58	58	58	58	58	58	58	58	58	58
BWS-Reject Science v No Science										
Degrees of freedom (*DF*)	108	118	130	117	139	122	125	132	119	104
t – value (*t*)	0.97	1.37	1.55	-0.53	-0.75	-0.59	-0.01	-1.25	-2.31	-1.05
p – value (*p*)	.3333	.1743	.1233	.5952	.4566	.5581	.9891	.2147	.0226	.2945