# WHAT ARE THE FACTORS INFLUENCING PRE-SERVICE TEACHERS' THEORY OF ACTION ABOUT STRATEGIES FOR MOTIVATING STUDENTS TO LEARN SCIENCE?

by

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CERTIFICATE OF ORIGINAL AUTHORSHIP

*I, Davis Leonard Kevin Jean-Baptiste, declare that this thesis is submitted in fulfilment of the requirements for the award of Doctor of Philosophy, in the School of International Studies and Education, Faculty of Arts and Social Sciences at the University of Technology Sydney.*

*This thesis is wholly my own work unless otherwise referenced or acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis. This document has not been submitted for qualifications at any other academic institution.*

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# DEDICATION

This doctoral degree is dedicated to:

The community of Lamaze, located in Choiseul, Saint Lucia. May all residents (past and present) be more motivated to seek higher education and remember the fundamental principle:

*"Ee pah ki kotae ou sorti nonplis sa ou ni, mais ee say un maatyer de ki loine ou vlay wayvay et allea kotae ou wayvay, et aussi ki saa ou fae epi timietla ou ni" (In French Kewyol)*

*"It is not where you come from and what you have, but it is a matter of how far you have dared to and follow a dream as well as what you do with whatever little you have."*

and

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## Glossary of Terms

In this Section, the researcher presents a definition of the main frequently referenced terms used throughout the thesis.

i. **Motivation**: “Motivation involves the process that energises, direct, and sustain behaviour” (p. 424, Santrock, 2018)

ii. **Initial Teacher Education [ITE]**: this refers to a set of programs and courses designed to train beginning teachers in specific academic disciplines in preparation for teaching students at either the primary school level, secondary school level or tertiary level.

iii. **Pre-service Teacher [PST]**: An individual pursuing an ITE program/ course of study.

iv. **Theory of Action:** Argyris & Schön (1974) defines the theory of action as a broad concept consisting of three elements theory-in-use, espoused theory, and congruence/incongruence between the two main aspects of the theory of action.

v. **Espoused Theory**: Espoused theory can be defined as those ideas, theories that an individual claims to follow in directing his action (Argyris, Putnam & Smith, 1985). An individual may have many espoused theories about a phenomenon.

vi. **Theory-In-Use**: Argyris & Schön (1974) states that the term theory-in-use is one element of the theory of action model that focuses on people’s behaviours. This element of the model is normally inferred and not generally known to persons. An individual may have many theories-in-use.

vii. **Beliefs**: This construct is defined by Richardson (1996) as “Psychologically held understandings, premises, or propositions about the world that are felt to be true.” (p. 103)

viii. **Perception**: This refers to an individual’s view of an event/phenomena based on his/her experiences (vicarious or personal) and his/her ontological assumptions.

ix. **Contemporary beliefs** about strategies for motivating students include widely accepted; by science educators, modern teaching strategies used by teachers in the classroom. Such strategies are generally student centred in nature.

x. **Traditional beliefs** about strategies for motivating students include didactic methods of teaching, where there is a strong teacher-centred learning environment.

## Abstract

Previous research has documented the decline in motivation for learning science among school students, particularly at the lower secondary level. The Australian Professional Standards for Teachers (AITSL, 2011) indicate that teachers need to *know students and how they learn*; this includes designing engaging learning experiences to motivate students. As established in previous studies, pre-service teachers' beliefs and professional identities are particularly open to change. However, there has been limited research to date that has investigated factors that influence pre-service teachers' theory of action about strategies for motivating lower secondary students to learn science. Furthermore, this aspect has not been examined in Australia.

This research was conducted in two phases over four months. Phase one of the study was conducted from August 2019 to early October 2019. Phase two data collection was done from October 2019 to December 2019. In phase one of the study, I used a web-based survey to gather data about pre-service teachers' beliefs about effective strategies for motivating science students and how they used those strategies during professional experience placements. Data about the factors that influenced the pre-service teachers' choice of strategies to motivate students to learn science were also gathered.

In Phase Two of this study, case studies were conducted with three secondary science pre-service teachers enrolled in their initial teacher education: secondary science program in regional New South Wales and their supervising teachers. Case studies were conducted to gain a deeper understanding of the factors influencing pre-service teachers' theory of action about strategies for motivating students to learn science during their professional experience placement. Moreover, the case studies provided me with an avenue to understand better how

factors influence pre-service teachers' choice of strategies for motivating students to learn science. In phase two, data gathering methods included semi-structured interviews with three pre-service teachers and their respective supervising teachers. Additionally, there was the use of documentation of the pre-service teachers' science lesson plans and science lesson observations to gather data about the secondary science pre-service teachers' espoused theory and how they planned on enacting their espoused beliefs during their science lessons.

Those research findings highlight the incongruency between what secondary science pre-service teachers believe about motivating students for learning science at the lower secondary school level and how they enact those beliefs during their professional experience placement. Moreover, this incongruency is further exacerbated by the difference between what pre-service teachers learn during their ITE program and their school practice. This finding of incongruency is critical as it is not only relevant to science education but to initial teacher education in general, and as such, this research contributes directly to the body of knowledge in this area.

Moreover, the findings of this research suggest that the participating pre-service teachers' beliefs about motivating students to learn science mainly originated from their own school experiences and from observing other teachers teach. Moreover, although most pre-service teachers' theory of action could have been categorised as contemporary/ modern approaches concerning motivating students to learn science, some pre-service teachers gave responses that deviated from widely accepted contemporary approaches to teaching science.

# Chapter 1

# Introduction

In this chapter, I will introduce the study. In Section 1.1, I will explain various impetuses that propelled me to conduct this research. Additionally, in Section 1.1, I will explain how those impetuses aided in conceptualising the study. The chapter will continue with Section 1.2, in which an explanation and discussion of the purpose of this research and the research questions to be addressed in this study are presented. I will provide an overview of the background of this study in Section 1.3, which considers the science education context. This section is followed by a presentation of the conceptions of the theory of action in Section 1.4.

Additionally, in this chapter, the significance of the study will be discussed in Section 1.5. This section will be followed by a discussion of the delimitations of the study in Section 1.6. The chapter will end with Section 1.7, where I summarise the chapter.

## 1.1. The Impetuses for this Study

Many reasons led to my interest in studying pre-service teachers' beliefs about and strategies for motivating students to learn science at the lower secondary school level. Those reasons comprise a mix of experience; personal and vicarious experiences, past research interest from my Bachelor and Master of Philosophy degrees, which gave me the propensity to want to know more about the phenomenon.

The first impetus for this research came through my reflections and experiences as a pre-service teacher. During the portfolio component of his initial (ITE) program, I realised that there was a vast discrepancy in the theory about motivating science students leant in during his methods courses and the strategies he used to motivate students to learn science during his professional experience placement. During my time at the ITE program, he conducted two professional experience placements. I was aware and understood that pre-service teachers engaged in professional experience placements to develop their experience in their subject disciplines, develop increased knowledge and sharpen their teaching skills (Maddamsetti, 2018). The theory-practice divide I experienced during the ITE program, which most of his colleagues from the ITE program affirmed, made me curious about why this theory-practice divide existed.

My second impetus came from my lower secondary school science teaching practice. As a science teacher, I was worried about the lack of motivation for learning science that his students often displayed at the lower secondary level. I knew that I had my beliefs about motivating students to learn science when I was a pre-service teacher, but I often wondered, how do other pre-service teachers believe that they can motivate science students to learn? And what strategies do pre-service teachers believe can motivate students to learn science? Moreover, I also wondered how pre-service teachers could enact those beliefs about strategies for motivating students to learn science? And whether pre-service teachers' beliefs change during their initial teacher education program?

My third impetus evolved from his previous two impetuses. To understand the theory-practice divide, the researcher conducted postgraduate research into strategies by which secondary science pre-service teachers can create and sustain students' long-term interest in science. Upon completing my postgraduate thesis, I realised that pre-service teachers' beliefs about the factors influencing those beliefs and how those beliefs may be enacted and possibly changed during their professional experience placement were generally not well researched. As a result of this revelation, I decided to pursue this current research to gain insight into pre-service teachers' theory of action to motivate students for learning science.

Due to the awareness of social influences surrounding my three impetuses, I began to focus on devising a methodology for studying pre-service teacher beliefs about and strategies for motivation from a social cognitive perspective. Consequently, I decided to employ a qualitative approach to gather my data at different time points from multiple participants. The primary data gathering methods used to collect data in this study were web-based surveys with secondary science pre-service teachers throughout Australia, science lesson observations, documentation of lesson plans and semi-structured interviews with secondary science pre-service teachers and their respective supervising teachers from regional New South Wales (NSW). The activities that were observed during the science lesson observations were recorded as field notes. The pre-service teachers' and their respective supervising teachers' perspectives concerning beliefs about strategies for motivating students for learning science were recorded using audiotapes.

Fundamental to this research were the social cognitive theory coined by Bandura (1977) (discussed in detail in Section 2.1 of this study) and the four principles of motivation, advanced by Turner et al. (2011) (discussed in Section 2.2 of this study). The social cognitive theory and the principles of motivations helped form a theoretical framework for this study which consequently helped me with the data analysis component of this study. Additionally, the data were gathered and analysed using the lens of the social cognitive theory. From the outset of this research, I anticipated that there would be a significant contribution made to how pre-service teachers' beliefs about strategies for motivating students are conceptualised. This conceptualisation of pre-service teachers' beliefs was anticipated to draw on the fundamental notions of the social cognitive approach, which encompass the triadic reciprocality model (discussed in Section 2.1.) of the social cognitive theory.

## 1.2. Purpose of the Study and Research Questions

This study aims to find out what factors influence pre-service teachers' theory of action about strategies for motivating students to learn science during their professional experience placement. Moreover, through this research, I am trying to help the science education research community better understand the different factors that shape teachers' beliefs of how they motivate students to learn science.

The following research questions will serve as a guide for this investigation into pre-service teachers' theory of action about strategies for motivating students to learn science in the context of their professional experience placement:

1) What are pre-service teachers' espoused beliefs about strategies for motivating students to learn science during their professional experience placement?
2) How do pre-service teachers enact their espoused beliefs for motivating students to learn science during their professional experience placement?
3) What factors influence pre-service teachers' theory of action about strategies to motivate students to learn science?
4) How do pre-service teachers' theory of action change as they progress through their professional experience placement?

## 1.3. Background

The importance of science in our everyday living cannot be underestimated. There are products of science and technology evident in all facets of our society, from road construction to space exploration (Rennie et al., 2019). Science enables us to make empirical judgements and sound decisions about phenomena that allow us to work together to become an economically efficient society. In our modern era, as our dependence on science and technological advances increases, so is our demand for more scientifically literate citizens (Udu, 2018). Therefore, to function as we know it, all citizens need to understand science and have critical scientific literacies (Ryder, 2001).

Scientific literacy is defined as the ability to use scientific knowledge to understand the world around us and participate in decisions that may affect it (Udu, 2018). Some of the most fundamental scientific literacies include the ability for an individual to engage in scientific material and scientific discourse, reading and writing in a scientific manner (Laugksch, 2000). The global population faces constant scientific challenges, including increased dangerous storms, diseases, food shortages, and reduced dependence on fossil fuels for sustainable living. The onus lies with members of the society who possess scientific knowledge to develop innovative solutions to pressing challenges (Udu, 2018).

We cannot expect members of society to possess a certain level of scientific literacy if there is no reliable science education program to teach them about critical scientific literacies in the first place. It is therefore vital to have good science education programs so that members of the society can learn various science competencies and possibly pursue science and science-related careers since the primary purpose of science education is to increase the flow of specialist scientists, technologists, and engineers (Tare et al., 2011). Tare et al. (2011) further assert that people with exceptional talent in science should be identified as early as possible and provided with a separate, specialised, and highly focused science education. Upon completing good science programs, students would participate in crucial debates and informed discussions on current issues such as climate change in a meaningful and objective manner. Science education is, therefore, a critical part of any country's development. Udu (2018) states:

> Science education has been recognised the world over as a prerequisite for scientific and technological development. It provides opportunities for students to acquire relevant functional knowledge and skills associated with scientific processes needed for advancement in science and technology. In science education, students are encouraged to develop and practice scientific skills (p.24).

It is crucial for countries to invest in science education. As Udu (2018) posits: "Science education is the engine for growth and progress of any society" (p. 24). When a country invests time and money into science education, it not only directly leads to students gaining scientific literacy but in the future leads to society being uplifted due to the ability of persons to offer science-based solutions to remedy complex scientific and mathematical problems and social problems that can serve to benefit humanity. For such growth within the society to be achieved, Udu (2018) further asserts that society must regard science education as "An engine of advancement in an information era propelled by its wheels of knowledge and researching leading to development" (p. 25).

Most people hoping to acquire a certain level of scientific literacy partake in Science, Technology, Engineering and Mathematics (STEM) based subjects to gain a strong science education background. Whilst STEM skills/education does not equate to science skills and education, science is a part of STEM and as such, science skills/knowledge forms an integral part of STEM. Consequently, science education is essential since students at all schooling levels, including secondary school and universities, should become interested in and motivated for learning science. Research by the Australia Education Council (2018) shows STEM education "Increases student interest in STEM-Related fields and improves students' problem solving and critical analysis skills" (p. 5).

However, although STEM is recognised as being of critical importance for the advancement of our modern global society, in our secondary schools, there has been a severe decline in science students' motivation for learning science and science-related subjects (De Silva et al., 2018). Vedder-Weiss and Fortus (2011) assert that many studies conducted on science motivation among students show that "… students' attitudes, interest, and motivation towards science learning decline throughout their years at school, especially during secondary school" (p.1162). The decline in science students' motivation toward learning science (discussed further in Section 3.2 of this study) is concerning and presents a fundamental challenge of having scientifically minded persons who can help deal with societal challenges when they come about (UNESCO, 2015).

Education researchers have defined motivation as the driving force to stimulate, guide, and maintain students' behaviours to achieve the desired conduct (Ilgaz & Eskici, 2019; Santrock, 2018). In the science context, Vedder-Weiss and Fortus (2011) add that science education researchers have reported that student motivation for learning science in primary and secondary schools has not increased over the past decade. Vossen et al. (2018) state that when students' progress through their schooling, more so as they transition from primary to secondary, science and science-related concepts are viewed as challenging, dull, and not being relevant to the real world. Allen (2016) agrees that this decline in motivation is more prevalent as students transition from primary to the lower secondary school years (years 6-9). Virtanen et al. (2019) further state that a general loss in the transition period from primary school to the lower secondary school student engagement weakened self-esteem and a decline in academic performance.

Many international science education researchers, professional science education organisations have pointed out the gravity of students' declining interest in science (Caspi et al., 2019; Ivanova & Korostelev, 2019; Renninger & Hidi, 2019). Allen (2016) points out that in the 2011 Trends in International Mathematics and Science Study (TIMSS), British-based students showed less interest and motivation for learning science in Year 9 than Year 5 students. Likewise, Sturman et al. (2012) assert that amongst British students, by Year 9, there were reports of fewer year nine students feeling engaged with science than in Year 5. Moreover, this decline in students' motivation for learning science was highlighted by Mohd Shahali et al. (2019). Mohd Shahali et al. (2019) conducted a longitudinal study on students' interest towards STEM in Malaysia and showed that students' lack of interest was the main contributor to the low numbers of students pursuing STEM-based areas. Students at the lower secondary school are not motivated to pursue science and science-related courses beyond compulsory science years in those transition years. The European Commission (2004) suggests that if there is a sustained lack of interest and motivation among science students, countries will experience a shortage of skilled, scientifically literate persons. Vedder-Weiss and Fortus (2018) also assert that the decline in student motivation in science is alarming and raises concern about the science-related professions and the level of scientific literacy within society in general.

There has been a plethora of research into the decline of student motivation for learning science in Australia. Science education researchers have pointed out that in Australia, students have generally lost motivation and enjoyment for science at the secondary school level and the post-compulsory school years (Chief Scientist, 2014; Pino-Pasternak &Volet, 2018; Tytler, 2007).

Timms et al. (2018) emphasise that one of the main challenges of science/STEM-based teaching in Australia is creating engagement and excitement amongst the students who pursue those science-based fields. Educators must find innovative ways to enthuse and motivate students to like science. This is important since Vedder-Weiss and Fortus (2011) claim that "…the decline in students' motivation for science learning might not be inevitable but rather connected to the way science is taught at schools" (p. 200).

Motivation amongst students at the lower secondary school level plays a vital role in shaping their long-term identity, interest in science, and their STEM career. Regarding shaping students' long-term identities, Williams et al. (2018) posit that when students engage in motivational experiences at school, this can help them further engage with the content to be learnt and help their identity. Williams et al. (2018) defined students' identity in the science class as the affinity for a student to belong "…in science and who may want to pursue science in college or career." (p.6). The research literature by Williams et al. (2018) suggests that they agree with the notion that motivation is essential to help build students long term identity in science. Other researchers such as Dweck et al. (2014) have indicated that when students are motivated to learn based on the teachers' use of specific instructional strategies, students may also be able to develop academic and social identities "…which itself can be motivationally galvanising" (p. 31). Moreover, concerning interest, Jean-Baptiste et al. (2019) have pointed out that when students are motivated to learn science, whether intrinsically or extrinsically, students are more likely to develop a long-term interest that can stay with them throughout their academic lives and career paths.

Teachers, therefore, play a vital role in motivating students to pursue science and science-related courses. UNESCO (2015) purports that teachers are the key players in improving all our children's learning in school. You et al. (2018) additionally assert that "Many educators have considered students' motivation as an important factor for successful learning" (p.1162). When students are motivated in science, they tend to develop a deeper understanding and learning of science and better grasp the intended learning outcomes (Palmer, 2004). To motivate students to enjoy and develop a long-term interest in science, teachers first must be scientifically literate and hold a comprehensive understanding of science concepts (UNESCO, 2015). Howells (2018) states that teachers should be empowered to use their professional knowledge, skills, and expertise to deliver the curriculum to motivate their students effectively. Howells (2018) asserts further that teachers are to display a passion and love for science during teaching so that their students can eventually begin to emulate them to develop an interest in and passion for science learning.

Therefore, a good starting point for student motivation is at the pre-service teacher level. In their study, Awad and Barak (2018) investigate how pre-service teachers are learning science, suggesting that unless teachers are qualified in science education, possess good science education training, and are motivated themselves, it would be a bit more difficult for them to motivate students in science. During their ITE program, pre-service science teachers are expected to spend time teaching during their professional experience placement. Riley Lloyd and Howell (2019) assert that sometimes those pre-service teachers experience a disconnect between the theories they learn during their ITE program and the types of strategies they use to get students to learn during their placement; that is, they experience a theory-practice divide. Historically, there has been a theory-practice divide in education, especially in science initial teacher education. Duffy and Anderson (1984) assert that "The issue is how teachers can apply theoretical knowledge in real classrooms where the relationship between theory and practice is complex and where numerous constraints and pressures influence teacher thinking" (p.103).

In addition to their in-class learning during the ITE programs, pre-service teachers come into their programs with many beliefs and strategies about how they think they can motivate science students to become fully-fledged science teachers (Beeth & Adanan, 2006). Ferguson and Brownlee (2018) state that the beliefs pre-service teachers hold about the nature of knowledge and knowing will likely have “Important consequences for the nature of the content delivered of their future classrooms” (p.94). Therefore, it is at the ITE level that science educators should play a part in helping the pre-service teachers develop their espouse beliefs (explained in Section 1.4 of this study) theories of science motivation and help guide them on methods by which those espoused theories, as well as those being learnt in class, can be enacted during the ITE program.

Knowledge of pre-service science teachers’ espoused beliefs about strategies to motivate students to learn science and the factors that influence pre-service teachers’ enactment of those beliefs is a vital step for narrowing the theory-practice divide in teacher education. Korthagen (2010) states that the effects of teacher education on the actual practice of teachers are generally insufficient as this does not help close the theory-practice divide that exists. As such, to assist in narrowing the theory-practice divide that exists in teacher education, a deep understanding of pre-service teachers’ beliefs in the context of their professional experience placements opens the road to dialogue on the phenomena of how those beliefs about strategies can help motivate students for learning science.

## 1.4. Conceptualisations of Theory of Action

The concept theory of action was coined by Argyris and Schön (1974). Argyris and Schön (1974) suggested that the concept theory of action was made up of espoused theory and theory-in-use. Furthermore, Argyris and Schön (1974) posit that the theory of action involves determining whether there is congruence/incongruence to be explored between an individual's espoused theory and their theory-in-use. Kerr and Todd (2009) define theory of action as being "Master programs, governing variables, values, theories, beliefs, concepts, rules, policies, practices, norms, or skills that underlie our actions" (p.4). In this research, I will be examining pre-service teachers' espoused theories and theories-in-use (to be described further in Sections 1.4.1.1. and 1.4.1.2, respectively) concerning motivating students to learn science at the lower secondary school level.

### 1.4.1. Theory of Action

The theory of action helps explain persons' thought processes and actions by considering the factors that may be responsible for their congruence or incongruency (Argyris & Schon 1974; Argyris et al. 1985). Jones (2009) explains that theory of action is the "…repertoire of concepts, schemas and strategies which form a plan of action and are comprised of the beliefs and values and assumptions which are designed to bring about the desired outcome" (p.177). The theory of action was conceptualised by Argyris and Schön (1974) as a broad concept consisting of two main elements: espoused theory and theory-in-use. Jones (2009) suggested an individual's espoused theory "…encompasses the world view and values upon which people believe their behaviour to be based" (p. 177). Jones (2009) went on to assert that one's espoused theory is a "formal, idealised account of the reasoning underpinning their action and encompasses their aims and intentions" (p. 177). The second component to the theory of action is theories-in use, which was seen as tacit knowledge that an individual could not easily verbally articulate (Bereiter & Scardamalia, 1992; Polanyi 1966). Jones (2009) indicated that a person's theories-in-use is a theory that underpins action and determines behaviour. Jones (2009) stated, "Theory-in-use is the set of values suggested by action or the maps people use to take action" (p.177).

Chapter 1: Introduction

There have been various studies in which educational researchers have made a case for highlighting the importance of teachers' perceptions/beliefs as being an essential element in the teaching/learning process. For instance, Stewart (2015) investigated whether education professionals' theories-in-use were in congruence with their espoused theories regarding the inclusion of parents as team decision-making partners in the initial education meetings at schools. The aforementioned studies' main limitation is that they did not examine the theory-practice divide pre-service teachers may experience during their professional experience placement. Another study by Jones (2009) pointed out that there is a gap between teaching generic science disciplines and how it is being enacted in the classroom by teachers. Therefore, this shows that having a knowledge of teachers' beliefs about the subject can pave the way for them to teach the subject better.

Previous studies have shown that theory of action only focused on education in general and not specifically on science education at the lower secondary level. One such example of this was found in research conducted by Kheirzadeh and Sistani (2018), who concentrated their research to discover whether there was any relationship between EFL teachers' reflectivity and students' language achievement. They conducted their research by observing and surveying 83 EFL teachers at nine institutions in Iran. Kheirzadeh and Sistani (2018) concluded that teacher reflectivity or implicit theories about their EFL teaching might influence student achievement. In the context of Kheirzadeh and Sistani's (2018) study, it can be seen that the theory of action was essential since, in the EFL teachers' reflections, they would have espoused their beliefs on how their EFL teaching can enhance their students' performance whilst the researchers observed their theory-in-use. In this current research, the previous research is essential since it offers a lens through which I can investigate the pre-service teachers' theory of action to motivate students to learn science at the lower secondary school level.

The case study design has been used by many researchers studying the concept theory of action. For instance, Rosari (2012), in her doctoral thesis, utilised a case study design to investigate a teacher education leadership course that espoused and enacted theories of leadership and how students experience them at different stages in their training. She did this by interviewing five faculty members and 30 students and document analysis on the program structure. The interviews served as a means of understanding the espoused theories/beliefs of the participants. It was found that the faculty of education helped students create, grow and change their ideas/beliefs of teacher leadership roles. The results from the case study conducted by Rosari (2012) are promising since it guided my research design and provided some initial insight and understanding of the concept theory of action pertaining to the teacher education context.

The examples, as mentioned earlier, of theory of action in international education research are promising. However, based on my readings, I have not found any literature which speaks to the theory of action about strategies for motivating students to learn science by secondary science pre-service teachers in the local Australian context.

#### *1.4.1.1. Espoused Theory*

Argyris and Schön (1974) purport that teachers hold micro theories/beliefs that they espouse to design and carry out their teaching. Argyris and Schön's espoused theories can also be understood as being synonymous with a persons' beliefs, perceptions, and values about a specific phenomenon (Pajares,1992). Although Dewey (1938) polarised the concept of beliefs/perceptions into traditional and contemporary/modern, Argyris and Schön (1974) believed that there should be a multifaceted approach to understanding what one espouses/believes/perceives about a situation and why a person will espouse views the way they do about that given situation. Due to the alternate names given to espoused theories by researchers such as Argyris and Schön (1974), the alternate terms to espoused theory, namely, beliefs, ideas and perceptions, will be referenced throughout the study. Richardson (2003) states that pre-service teachers bring deep implicit beliefs about the nature of teaching, learning, and schooling in general. Those tacit beliefs, also viewed as espoused theories, can be enacted to become workable theories-in-use (Ferguson & Lunn Brownlee, 2018).

#### *1.4.1.2. Theory-In-Use*

Argyris and Schon (1974) define the concept theory-in-use as one element of the theory of action model that focuses on people's behaviours. Argyris et al. (1985) assert that a person's theory-in-use is typically inferred; thus, it is generally unknown to persons. Theory-in-use comprises of two main components; (a) governing variables, which are defined as values that holders attempt to satisfy, and (b) behavioural strategies, which are behaviours that persons use to satisfy as many governing variables as possible (Argyris & Schon, 1974).

Pertaining to this research, a teacher's decision to use a particular strategy to motivate students for learning science can result from his/her values/ governing variables, and they may use various behavioural tactics to do so. Argyris and Schon (1974) posit that for anyone to satisfy those governing variables, they are to use behavioural strategies such as:

1. Advocating a position and unilaterally controlling others to win that position
2. Unilaterally controlling tasks to be done
3. Unilaterally deciding how much people are told about what is being held and distorted.

In the context of this research, pre-service teachers' theory-in-use, also referred to as theories-in-use can be expressed as any of the behavioural strategies stated above. For instance, pre-service teachers can advocate their position on a specific science topic that he/she wants the students to adopt that position as well. Moreover, pre-service teachers can choose specific pedagogical strategies to support students' achievement of the objectives for that science lesson.

In this research, factors influencing pre-service teachers' theory of action about strategies for motivating students to learn science will be investigated through the lens of social cognitive theory (discussed in Section 2.1 of this study). I assert that this is important to note as pre-service teachers teach in a social setting, the classroom, and the school environment (Auster & MacRone, 1994). Pre-service teachers' theory of action is also affected by various factors; some may be social, which influences the choice of strategies for motivating students to learn science during their teaching. Those factors may also be based on their governing variables/ values, which can also be influenced by the social world in which they live (King, 1993)

## 1.5. Significance of the Research

The research literature from around the globe provides evidence of the types of problems and issues facing science education, especially at the lower secondary school level (Palmer, 2004). For science teaching at the lower secondary school level, the main problem includes the uncertainty in the ability to teach science and the lack of confidence to motivate students to pursue science and science-related subjects (Palmer, 2004). Pre-service teachers who intend to become teachers are holders of many beliefs, often antagonistic toward science, and may not feel efficacious in teaching the subject (Awad & Barak, 2018; Jean-Baptiste et al., 2019). For the learning of science, there are concerns that students at the lower secondary school level are not motivated to learn science and decreased interest in science which leads to poor performances on national and international tests such as PISA and TIMSS (Krapp, 2002; Office of the Chief Scientist, 2016).

Governments of many advanced countries, such as England or Finland, are developing and are continually implementing national STEM-based policies to ensure the continued sustainability of their natural resources and economy. They have additionally articulated the need for most if not all of their population to be scientific literate within a specific timeframe (Education Council, 2018). In Australia, the vision for a scientifically literate population by the year 2022 is captured in a 2014 report by the Office of the Chief Scientist. This, therefore, requires the problems with science education to be addressed with a growing sense of urgency, and as such, we need to have our eyes set on the pre-service science teachers who will be charged with teaching science students in the future.

Therefore, this study investigated the factors that influenced secondary science pre-service teachers' beliefs about and enactment of those beliefs about motivating their students to learn science during their professional experience placement. To do so, I investigate secondary science pre-service teacher beliefs and how they used various strategies to motivate students during their professional experience placement.

### 1.6. Delimitations of the Study

This study investigated pre-service teachers' theory of action about strategies for motivating students to learn science at the lower secondary school level in Australia. Therefore, this study is not meant to obtain a detailed account of the nature and origin of the beliefs of each teacher but simply to understand the reason for the strategies that pre-service teachers use to motivate science students.

The research was conducted in two phases, with both phases containing different populations. The population consisted of secondary science pre-service teachers enrolled in an ITE program at universities throughout Australia in phase one. Phase two of the research comprised of three pre-service teachers conducting their professional experience placement at secondary schools in regional New South Wales (NSW). Data were also gathered from the three pre-service teachers' supervising teachers during phase 2 of this study. Despite the commonalities of the pre-service science teachers participating in this study, with other pre-service teachers studying other subjects within NSW and Australia, the findings of this study cannot be generalised to pre-service teachers in NSW or pre-service teachers in Australia. However, I am hopeful that the results of this study can stimulate similar research in other fields of education, for example, English and Mathematics and thus shed further light on the importance of teachers' beliefs about strategies that can enhance student motivation to learn certain subjects throughout Australia.

## 1.7. Chapter Summary

I provided the impetuses for, as well as the purpose of the study in this chapter. The impetuses for the study were described as it gave some insight into the personal reasons for examining pre-service teachers' theory of action about strategies for motivating students to learn science at the lower secondary school level. Additionally, in this chapter, I introduced the research by contextualising the main issues and terms to be referenced throughout the study. The background of the study was discussed to provide an understanding of general issues, which led to the more specific issue of what factors influence pre-service teachers' theory of action about strategies for motivating students to learn science being studied in this research. Moreover, the background served to uncover the contextual issues from the literature that influenced the research, highlighting the need to study pre-service teachers' theory of action about motivating students at the lower secondary school level to learn science. The study is significant in terms of the potential pedagogical implications of teachers espoused theories and theories-in-use for motivating science students at the lower secondary science level.

This thesis contains seven chapters. I discuss the theoretical framework to include the philosophical underpinnings and assumptions in chapter two of the study. A review of the literature will be presented in chapter three, where consideration is given to the strengths and limitations of previous research on the teachers' beliefs, including where those beliefs originate and how those beliefs are conceptualised in the context of pre-service teachers learning and teaching. In chapter four, I present the methodological design of the study. Additionally, in chapter four, a discussion of the research context, research questions and the methods used to carry out the research is presented. Moreover, in this chapter, I discuss the two main phases of the research: including the participants of each phase, the justification for each phase and the approach to data analysis and interpretation.

After the methodology chapter, I present two findings chapters, chapters five and six, to discuss the data gathered. Chapter five presents and analyses the findings from phase one of this research, the nationwide web-based survey. Chapter six presents findings from the investigation of three science pre-service teachers conducting their professional experience placement at respective secondary schools in regional New South Wales (NSW). Chapter seven concludes the research and presents this study's recommendations and implications.

# Chapter 2

# Theoretical Framework

## Introduction

In the previous chapter, I presented the impetuses, background, and context of the study. Additionally, my impetuses for conducting this study were also provided in the previous chapter. I highlighted that students' motivation for learning science at the lower secondary school level in Australia is declining. As a result of this decline in motivation, I made a case for studying pre-service teachers' beliefs about and strategies for motivating students at the lower secondary school level and how those strategies are enacted during their professional experience placement.

In this chapter, an analytical framework is presented to provide a baseline understanding of the primary theoretical lenses through which data were analysed in this thesis. Two main approaches guided this study of pre-service teachers' beliefs and enactment of strategies to motivate science students in the science classroom context: the social cognitive theory (Bandura 1995), which Albert Bandura first envisioned, and Turner et al.'s (2011) principles of motivation.

This chapter is organised as follows: In Section 2.1, I discuss social cognitive theory and how it was used to interpret the data gathered in this study. In Section 2.2, the principles of motivation are presented and discussed in the context of the pre-service teachers' strategies for motivating science students. The chapter ends in Section 2.3 with a summary of the theoretical framework used in this study.

## 2.1. Social Cognitive Theory

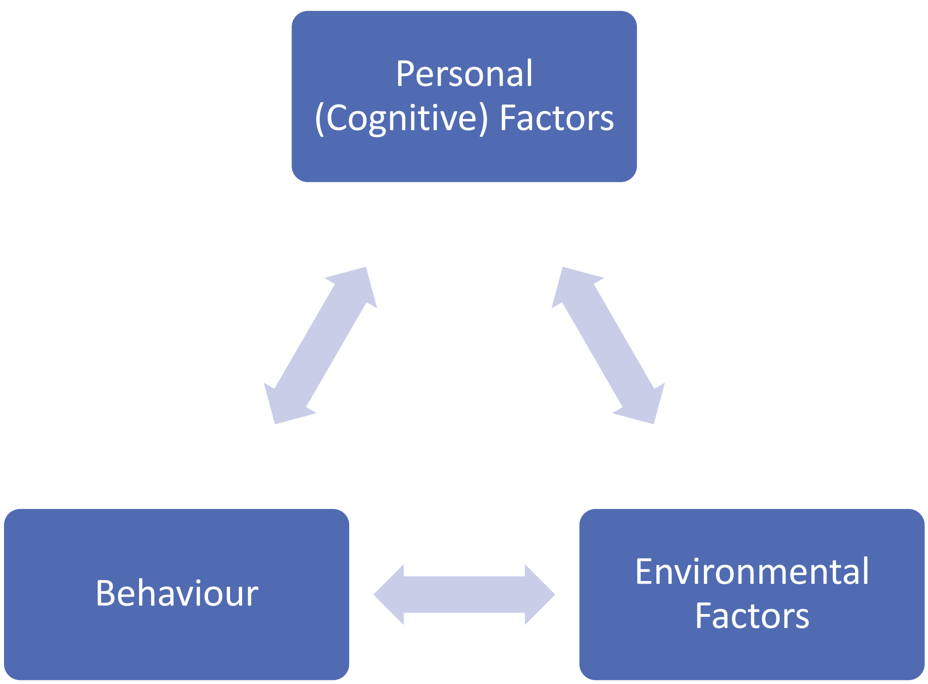
Social cognitive theory (SCT) was chosen as the main theoretical framework best suited to analyse and interpret data concerning the factors influencing pre-service teachers' beliefs and enactments of those beliefs found in this study. It must be noted that in this study, the pre-service teacher adopts the role of a student and a teacher, and as such, the pre-service teacher is expected to learn about strategies for motivating students to learn science, and also practise enacting those strategies as a teacher during his/her placement. Therefore, the social cognitive theory offers a suitable lens to examine how the pre-service teachers have developed their belief structures, how they develop those beliefs and the factors that influence the formation of their beliefs, enactments and possibly a change of belief structures during their professional experience placement. Education researchers have described a social cognitive theory as a psychological perspective on human functioning that emphasises the critical role played by the environment on motivation, learning and self-regulation (Schunk & DiBenedetto, 2020; Schunk & Usher, 2012). Bandura (1977) developed a social cognitive theory and described it as a bridge between behavioural and cognitive learning theories.

In this study, I considered the central focus of Bandura's (1977) social cognitive theory that focuses on how human behaviour operates within the concept of the triadic reciprocality model. In Figure 2.1, the triadic reciprocality concept forming the social cognitive theory is shown. Bandura's (1977) concept of triadic reciprocality involved reciprocal interactions among three sets of influences: personal (e.g., cognitions and beliefs), behavioural (e.g., actions), and social/environmental factors (e.g., members of the society). Personal factors, also called cognitive factors, as described by Bandura (1995), were viewed as those factors that surrounded the individuals, beliefs, intentions, emotions and encompassed their cognitive events (observational learning), biological events (temperament) and their affective events (personal and vicarious experiences). The environmental factor component of the triadic reciprocality model was conceptualised by Bandura (1995) as any event from the environment, e.g., time, the weather, classroom culture, that has the potential to influence an individual's personal factors and, consequently, behaviour.

Moreover, researchers (e.g., Schunk & DiBenedetto, 2020; Schunk & Usher, 2012) have suggested that the social cognitive framework is often employed to explore the outcomes of cognition and behavioural processes underlying motivation. This is crucial because Bandura (1977) has stated that motivation is a prominent feature of SCT. I assert that the social cognitive framework was the most fitting framework for this study because it provides a comprehensive way of analysing the factors that may influence pre-service teachers' beliefs about and enactment (behaviour) of strategies for motivating students to learn science.

**Figure 2.1**

*Triadic Reciprocality Model of the Social Cognitive Theory*




*Adapted from* Schunk and Usher (2012)

### 2.1.1. Personal (Cognitive) Factors

The first aspect of this triadic reciprocal concept of the social cognitive theory focused on personal/ cognitive factors. The personal factors investigated in this study include pre-service teachers' self-efficacy and observational learning. Schunk and Usher (2012) suggest that personal influences include self-efficacy and cognition, perceptions, beliefs and emotions. The personal factors bear direct relation to this study since, in this study, as part of the theory of action, I investigate pre-service teachers' beliefs about strategies for motivating students for learning science as part of theory of action. Schunk and DiBenedetto (2020) suggest that personal factors are not isolated from other factors such as teachers' actions in the classroom. Schunk and DiBenedetto (2020) state, "What people think can affect their actions and environments; actions can alter their thoughts and environments…" (p. 2). Therefore, these personal factors support Argyris and Schon's theory of action, where it is believed that persons thought processes influence their actions. I consider this premise when investigating pre-service teachers' espoused theories, their theories in use, and how pre-service teachers' theory of action about strategies for motivating students to learn science changes during their professional experience placement.

#### *2.1.1.1. Self-Efficacy Beliefs*

One of the critical personal influences that pertain to this study is the concept of self-efficacy. Bandura (1997) defined a person's self-efficacy as being "The exercise of human agency through people's beliefs in their capabilities to produce desired effects by their actions" (p. vii). The concept of self-efficacy has an important bearing on the analysis of the finding of this study since Trujillo and Tanner (2014) suggested that self-efficacy was a critical "aspect of social cognitive theory" (p. 7). Furthermore, Bandura (1995) states that self-efficacy beliefs, being an integral part of their personal factors, determine how people think, feel, and ultimately behave. Moreover, Schunk and Usher (2012) claim that people act according to their beliefs about their capabilities and the expected outcomes of their actions. In the context of this study, per-service teachers' self-efficacy beliefs are crucial to consider since those beliefs can determine their espoused beliefs about strategies for motivating science students to learn, and they enact those strategies during their placement.

Furthermore, Trujillo and Tanner (2014) assert that self-efficacy has been shown to mediate several factors such as the extent to which students feel belongingness in the class, academic achievement, motivation/perseverance to learn a task. Schunk and DiBenedetto (2020) posit that teachers with higher levels of self-efficacy beliefs are more likely to engage students in challenging learning and persist in helping students learn. This assertion by Schunk and DiBenedetto (2020) seems to provide more evidence that teachers' self-efficacy beliefs determine their course of action in the classroom when teaching. In the same way, in this study, it is expected that pre-service teachers' self-efficacy beliefs would determine their theory of action.

#### *2.1.1.2. Observational Learning*

Observational learning was cited as another significant sub-component of the personal factors category of the triadic reciprocality model (Bandura 2005). Observational learning explains how people's thought processes and behaviours are influenced, noting the consequences of other persons' actions in a particular context (Bandua,1986). I assert that one of the factors influencing pre-service teachers' theory of action about strategies for motivating students to learn science could have been due to their observation learning experiences at some point in their lives. Observational learning, despite its reliance on the consequences of others' actions, is categorised as a personal factor because the onus lies on the observer to pay attention and retain the information which they observe by using information processing techniques such as chunking and or coding before reproducing the behaviour (Bandura 1986).

In this study, there is an assumption that pre-service teachers' ideas about strategies for motivating students may have originated from them observing their supervising teachers or other colleagues teaching. As a result of this observation, the pre-service teacher would have had to pay attention to strategies that motivate students to learn science by retaining the strategies and then reproduce successfully observed strategies in their classroom during their professional experience placement. Bandura (2008) suggests that the focus of observational learning was the acquisition of attitudes, values, styles of thinking and behaviours by observing the examples provided by other people in similar contexts. Nabavi (2012) suggests that for observational learning to occur, there needs to be the imitating and modelling of a model's behaviours in a given situation by the observer. Nabavi (2012) continues to assert that persons learn many of their actions by engaging in observation and modelling. Bandura (1986) indicated that for observational learning to be effective, the individual must consider the following four elements: attention, retention, production, and motivation.

**2.1.1.2.1 Attention.** The concept of attention is based on Bandura's observational learning model and occurs when an individual intently observes another person perform a task in a particular context. Grusec (1994) asserts that the observer must pay attention to live or symbolic events before modelling the observed behaviour. The importance of attention to observational learning was also expressed by Morse et al. (2019), who suggest that attention could be classified as physical attention, verbal attention, and cognitive attention. Bandura (1977) states that physical attention refers to any tactile experience the observer may feel during the observation period. Bandura further explains that physical attention can be increased by accentuating the essential features of observed experience. Verbal attention refers to the extent to which the observer can communicate with the model during observation. Bandura suggested that when the observer receives attention directing narrations, he/she would be more likely to model the observed behaviour. Morse et al. (2019) argue that cognitive attention refers to the extent to which an observer engages in reflection about their observed experience.

Bandura (1986) states that cognitive skills and competencies are essential attributes that an observer should contain to gain new behaviour through observation. Janelle et al. (2003) claim that the subcategories, as mentioned earlier of attention, allow for the formation of information-rich symbolic representations of observed behaviours.

**2.1.1.2.2. Retention.** The second concept of observational learning is retention. Grusec (1994) states that retention occurs when the observer engages in mental rehearsal via imagining or developing a verbal representative system of the observed behaviour. For an observer to be involved in the retention process, he/she must have the ability to recall the observed behaviours demonstrated by the model (Morse et al., 2019). Janelle et al. (2008) argue that the sub-processes attention and retention are critically connected in the form of cues before the observer can go to the next subprocess in observational learning. Janelle et al. (2008) continue to assert that any cues attended to by the observer become primary cues that the observer relies upon to visually and verbally code the observed behaviours. As it relates to my research, after the pre-service teacher observes a strategy being used by a particular model (their lecturer, supervising teacher, other colleagues), there is the expectation that he/she will try retaining how to use that strategy to motivate his/her students, for instance, via verbalisation, during his/her placement.

**2.1.1.2.3. Production.** The term production as a subprocess of observational learning was conceived by Bandura (1986) to describe a process where the observer reproduces the observed behaviour. For this subprocess to occur, the observer must convert symbolic representation from the retention phase into actions similar to the previously observed behaviour and the context within which it was observed (Grusec, 1994). In this thesis, how secondary science pre-service teachers enacted the strategies they possibly observed from their colleagues, lecturers and supervising teachers is uncovered and explained in chapters 5 and 6.

**2.1.1.2.4. Motivation.** The final subprocess of observational learning is motivation. According to Bandura (2008), motivation occurs when the observer successfully reproduces the observed behaviour in a similar context. It must be noted that the construct motivation, as part of the observational learning process, is treated differently from the principles of motivation described in Section 2.2. of this research. The reason for this conceptually different view of motivation in the two Sections was mainly because, in the present Section, motivation refers to the pre-service teachers' motivation to learn strategies for motivating students, that is, during the formulation of their beliefs about strategies for motivating students to learn. However, in Section 2.2, motivation refers to how the pre-service teachers use strategies during their teaching to motivate students to learn science; that is, their theory-in-use.

Grusec (1994) argues that there must be sufficient incentive present for the observer to reproduce the observed behaviour. In this thesis, this subprocess motivation is essential because pre-service teachers' use of a specific strategy to motivate science students would be dependent on two central factors. The first factor would be how the pre-service teacher observed other teachers successfully using specific strategies to motivate students for learning science. The second factor would be the motivation they would get from their supervising teachers and others, including the responses from the students, after enacting specific strategies to motivate students for learning science. For instance, Bandura (1997) asserts that if the feedback received others from was positive, the observer would be inclined to continue reproducing their behaviour. In the case of this study then, if the pre-service teachers gain positive feedback from their supervising teachers; for example, if the pre-service teacher is told that his/her use of strategies is a success, then the pre-service teacher would be more inclined to keep enacting the particular strategy motivate students for learning science. Additionally, if students seemed to have been motivated to learn when the pre-service teacher used a particular strategy, the pre-service teacher would be motivated to keep using the strategy during science lessons. As part of the motivation component, the provision of feedback to the individual learning, in this case, the pre-service teacher, is seen as being integral in determining whether that individual will continue a behaviour or not (Bandura 1977).

*2.1.1.2.4.1. Scaffolding.* The concept of scaffolding is an essential part of observational learning within the personal factor category which helps persons learn via feedback about a learning task/ behaviour from more competent individuals. The feedback provided to persons on their behaviours can serve as a form of scaffolding which is vital (Bandura, 1995). Education researchers have traditionally defined scaffolding as the process by which a teacher or more knowledgeable peer assists a learner, altering the task so that the learner can accomplish the task or solve problems that would otherwise be out of reach (Collins et al., 1989; Reiser, 2004; Wood et al., 1976). Sivan (2010) likened scaffolding to assisted learning and was conceptualised as the formation of interpersonal relationships (Sivan, 2010). Sivan (2010) suggested that scaffolding "…is a method by which instructional goals are integrated, the student's cognitive and affective needs are able to be met, and the child can be helped to achieve motivational competency." (p. 222). Moreover, Reiser (2004) and Rogoff (1990) assert that this assisted/scaffolded learning is associated with Vygotsky's (1978) conceptualisation of the zone of proximal development, which describes a region between where the learner is and what the learner can accomplish with the assistance of more competent peers/ adults.

In the educational setting, the term scaffolding has been used to refer to any assistance that the student receives from a more competent peer or adult (Vygotsky, 1978). As such, Turner et al. (2011) asserted that scaffolding is essential to ensure that students become competent in learning a task and become motivated to learn. Mercer (1995) states that the primary goal of scaffolding in teaching is to allow the teacher to gradually transfer the responsibility of a given task to the student. Clark and Graves (2005) argue that there are three main types of scaffolding, moment-to-moment verbal scaffolding, instructional frameworks that foster content learning, and instructional procedures for teaching. In this study, the aforementioned types of scaffolding are critical because it has been found that pre-service teachers use scaffolding in several ways to motivate students for learning.

Reiser (2004) suggests that moment to moment verbal scaffolding is also referred to as scaffolding talk in science teaching. During this scaffolding talk, science teachers engage in two functions: structuring and problematising. Reiser (2004) continued to assert that the structuring function involves providing structured workspaces to help learners decompose a task and organise their work or prompts to help learners recognise essential goals to pursue. In this study, it was found that examining pre-service teachers' science lesson plans provided a way of understanding how they structure their science lessons and planned strategies to motivate science students during their professional experience placement. The second aspect of the moment-to-moment verbal scaffolding, problematisation, deals with increasing the complexity of the task given to the student (Hiebert et al., 1996; Reiser, 2004). In the context of my research, problematisation is essential as it serves as a factor that helps determine how pre-service teachers' beliefs are developing to motivate science students.

Additionally, the continued use of the problematisation scaffold and belief in its effectiveness for motivating science students by the pre-service teacher during teaching would determine how well the pre-service teacher learned and consequently implemented the scaffold. For instance, if a pre-service teacher gives students work that is too easy for them, they may get bored and not be motivated to learn science. On the flip side, if pre-service teachers give students complex and way tasks above their current level, they may become frustrated with the tasks and not be motivated to learn science. In my study, one of the ways in which moment to moment scaffolding could have been noticed was by the structure and complexity of the tasks that the pre-service teacher gave the students to perform.

Creating an instructional framework is another type of scaffolding that is essential for teachers to encourage students' content learning and improve students' understanding and learning of the subject matter (Clark & Graves, 2005). Clark and Graves (2005) state that verbal scaffolding may or may not be included as part of an instructional framework scaffold strategy. They suggest that teachers structure their lessons within the instructional framework scaffold strategy to help students attain the intended learning outcomes. In this study, I uncover how pre-service teachers use their science lesson plans, classroom arrangement, and verbal prompting to the students helped facilitate this type of scaffolding. Uncovering this type of scaffolding in the study helps shed light on how pre-service teachers develop their theories-in-use to motivate students to learn science.

The use of instructional strategies as a form of scaffolding students to be motivated for learning science is perhaps the most relevant form of scaffolding for this research. Clark and Graves (2005) argue that teachers' instructional strategies should lead to students becoming independent learners. Additionally, Clark and Graves (2005) posit that in this type of scaffolding, the teacher gradually transfers responsibility for strategy use as students become increasingly competent in the learning environment. This scaffolding is vital to this research because the instructional strategies for teaching chosen by the pre-service teacher can also motivate students to learn science. Moreover, instructional strategies for teaching can serve to explain how the use of instructional strategies can lead to the further development of their beliefs about strategies for motivating students to learn science. For this type of scaffolding, I expected that the teacher would use appropriate instructional strategies such as demonstration, group work, discussion, experimentation, and field trips tailored to the relevant concepts to be taught to the students.

The structure for autonomy comes when science teachers allow students to rehearse the steps of a specific demonstration and then reproduce this demonstration successfully when they get the chance to do so. Bandura (1978) supports this view by suggesting that when someone pays attention to an event and can mentally rehearse the steps involved and is given the opportunity to practice, then the individual will be motivated to continue performing that behaviour. Concerning the science lessons espoused by the pre-service teachers where the demonstration strategy is used, this researcher asserts that the concept of observational learning applies.

Pertaining to the use of demonstrations in the classroom environment, researchers such as O'Brien (1991) have explained that demonstrations are a relevant, safe, simple, economical, enjoyable and effective strategy to motivate students. Furthermore, Skinner and Belmont (1993) contend that demonstrations provide teaching and learning opportunities since students will be given an initial structure that supports autonomy and interactions. Other researchers (e.g. Meyer et al., 2003 and Sherburn, 2012) are of the view that the use of demonstrations can allow students to ask questions about concepts that they observe and thus develop higher-level thinking skills such as analysis, characterisation, evaluation, and synthesis. Moreover, Miller (1993) also explained that a positive learning community is created when science engages in demonstrations. There is increased collaboration amongst students, which leads to a sense of community in the classroom. Research by Palmer (2007) supported the findings of the web-based survey and demonstrated the link between demonstration motivation by suggesting that in science classes, demonstration can arouse students' curiosity and motivation for learning science.

Despite the pre-service teachers suggesting that using field trips as a strategy can be time-consuming and may not be able to plan and execute it to motivate students for learning efficiently, Behrendt and Franklin (2014) contended that there are measures that can be instituted so that teachers could plan and execute field trips in a time-efficient manner. They suggest that this can be done via the use of virtual field trips on the computer or by having informal field trips. Hofstein and Rosenfeld (1996) suggested a positive relationship between the use of informal field trips, where science students engage in casual visits to informal settings, and students' level of intrinsic motivation. Rennie (2014) contends that students become more intrinsically motivated during informal field trips because the interaction is unforced, and the students would feel at ease in the informal learning environment, thus engaging in more social interactions.

### 2.1.2. Environmental Factors

Environmental factors are described in terms of the social and physical context in which the individual's behaviour occurs (Bandura, 1995). Vicarious experiences are an essential part of this social context within which persons learn, and as Schunk and Usher (2012) assert, much of human learning occurs vicariously, and vicarious learning offers an efficient alternative to learning via direct experiences. The primary type of vicarious experience that pertains to the environmental factors of the triadic reciprocality model is Response facilitation. Schunk and Usher (2012) suggest that response facilitation deals with the learning of socially acceptable behaviours. Moreover, Schunk and Usher (2012) state that the behaviours of others motivate observers' actions. Skamp and Mueller (2001) continued to posit that there is a strong link between pre-service teachers' beliefs and how it is shaped by their observation process of their supervising teachers' teaching during their professional experience placement. They pointed out that the experience of observing science teaching can be both a positive and negative experience, and this depends on how the supervising teacher teaches science, how effective the supervising teachers' teaching is and the supervising teachers' attitude toward science.

In the context of this study, the pre-service teachers' enactments of their beliefs will be determined by the presence of the social world (e.g., classroom culture, supervising teacher, placement school, friends or family), and the physical world, such as resources present in the classroom and time available for instruction. Furthermore, there is consensus amongst science researchers such as Palmer (2005) and Palincsar (1998) that learning relies on the development of relationships with fellow students and learning with a skilful partner such as a teacher. In the context of this study, the formulation of espoused theories of the pre-service teachers can be highly subjective and individualised since pre-service teachers may espouse different beliefs based on their ontological assumptions about student motivation stemming from their interactions with the social environment. Additionally, Bandura (1995) suggested that the social aspect of the environmental component refers specifically to what people are present (or absent) and their attitudes, beliefs, and the ideas that those people hold. Schunk and Usher (2012) state that when persons interact with other individuals, they learn knowledge, skills, beliefs, rules, and attitudes from them. This causes persons to learn the appropriateness, usefulness, and consequences of behaviours in the context within which the behaviour is via observation and interaction with the model.

#### 2.1.3. Behaviour

The behaviour aspect of the social cognitive triadic reciprocality model is described as activities, effort, persistence and achievement and environmental regulation (Schunk & DiBenedetto, 2020) demonstrated by an individual in a given situation. Other researchers assert that persons who are motivated to succeed will choose to engage in activities that will allow them to learn and expend the effort and persist on challenging tasks to achieve their desired outcome (Schunk & DiBenedetto, 2020; Usher & Schunk, 2018). In the context of this study, this behavioural component is crucial as the pre-service teachers' behaviours; that is, their theories-in-use or enactments of their beliefs about strategies to motivate students to learn science may be influenced by their personal factors and the environmental factors.

### 2.2. Principles of Motivation

Motivation has been viewed as one of the most critical factors for constructing knowledge and forming beliefs, especially in education (Palmer, 2005; Sivan, 1986). Because motivation is a social construct that can involve various sub-concepts such as allowing students to construct their systems of meaning through interaction with others (Massenzio, 2001; Prawat & Floden, 1994), motivation is well situated in the social cognitive theory as a personal/ cognitive factor and therefore, it is well situated for the phenomenon being researched in this study.

I sought to use the four principles of motivation; developing students' academic competency, fostering belongingness, developing students' autonomy and fostering meaningful learning, developed by Turner et al. (2011), as part of the theoretical approach in this thesis. It was thought that those four principles were helpful to understand the context within which this study was conducted. In the classroom context, the principles of motivation proposed by Turner et al. (2011) interact with each other and form the basis upon which students in the science classroom should be motivated. The teacher is at the forefront of helping students become motivated by ensuring that they are engaged in activities that bring about their level of competence, gives the students a feeling of belonging and autonomy, and learn science in a meaningful way (Niemeic & Ryan, 2009). As it pertains to this study, therefore, the principles of motivation proposed by Turner et al. (2011) serve as the socially constructed and socially accepted concepts by education researchers such as Niemeic and Ryan (2009), guiding this research into how the pre-service teachers are enacting their beliefs about and using strategies to motivate science students.

I believed that motivation would be fitting to understand further how secondary science pre-service teachers enact their strategies for motivating students to learn science in the context of their professional experience placement. Researchers, for example, Pintrich and Schunk (2002), showed that there is a link between the roles that schools play in student motivation and the social influences on teachers' motivational strategies in the classroom context.

Turner et al. (2011), in their research into motivating students for mathematics learning, introduced four principles of motivation; supporting students' competence, belongingness, autonomy and making learning meaningful, which they viewed as spanning across the four main perspectives of motivation mentioned earlier. The four main principles of motivation were introduced by Turner et al. (2011) to understand changes in Mathematics teachers' practices and beliefs in the context of motivating students to learn. In this thesis, those four principles of motivation strengthen the social learning framework and provide a lens via which data about pre-service teachers' enactments of their beliefs about strategies for motivating science students could be interpreted in the context of their professional experience placement.

Additionally, I assert that the strategies brought forward by Turner et al. (2011) and mentioned under each motivation principle are viewed as contemporary strategies. Contemporary strategies for motivating students include widely accepted, especially by social learning theorists, modern teaching strategies used by teachers in the classroom. Such contemporary strategies encourage a student-centred learning environment where the focus of learning is on the student. Contemporary teaching strategies differ from traditional teaching strategies. Those traditional teaching strategies include didactic methods of teaching, where there is a strong teacher-centred learning environment.

**2.2.1. Developing Students' Academic Competency**

Competency has been described by many education researchers (e.g., Bandura, 1997; Deci et al., 1991; Turner et al., 2011) as including ways to achieve specific learning outcomes and feeling confident in their abilities in performing learning tasks. Students' academic competency for learning science concepts facilitates their general motivation for science learning at secondary schools (Wood, 2019). Over the past decade, education researchers have studied how science students' competency to learn can be supported (Lijium et al., 2021; Prosekov et al., 2020; Car et al., 2013). For instance, in 2005, Kozma and Russell studied how science students develop competency. They concluded that science students' competency and their motivation to learn could be enhanced when science students use visualisations and models during science classes. Students are usually faced with demonstrating their competence in the science classroom by performing measurement and manipulation or planning and designing science experiments during summative or formative assessment periods. When a student perceives themself as incompetent in completing an academic task, that student is likely to be disengaged and demotivated to continue pursuing that task (Deci et al., 1991; Painter, 2011). On the contrary, when students believe that they are competent in an area, they tend to display a higher level of motivation toward learning the intended learning outcome than if they had a lower competency level in a given area (Wood, 2019; Turner et al., 2011). When a student perceives themselves as incompetent in completing an academic task, that student is likely to be disengaged and demotivated to continue pursuing that task (Deci et al., 1991; Painter, 2011).

There are many ways by which teachers can develop students' competency in science and, by extension, their motivation to learn science. Researchers (e.g., Turner et al., 2011) have pointed out the main ways by which students' academic competency for learning can be developed are by providing feedback to students, demonstrating that mistakes are informational, by helping students reflect on what they do and do not understand and why, and by offering to scaffold students.

#### *2.2.1.1. Providing Feedback to Students*

The first way students' competency can be developed is via the provision of feedback by teachers. Winstone et al. (2021) conceptualised feedback as a process where the learner makes sense of performance-related information that promotes their learning. Winstone et al. (2021) assert that feedback is "…one of the most powerful learning processes" (p. 1). Koenka and Anderman (2019) suggested that personalised feedback can also be referred to as "Specific, student-centred information delivered to students about their performance in a motivationally optimal manner…" (p. 15). Furthermore, about personalised feedback in the context of this study, Koenka and Anderman (2019) state that "Personalised feedback is arguably essential for middle school students" because "students often experience a decline in motivation and performance as they transition from elementary to middle school" (p. 16). Turner et al. (2011) suggest that to help develop students' competence, the teacher's primary role is to promptly provide high-quality feedback to students. In addition to giving feedback promptly, when giving effective personalised feedback to students, Koenka and Anderman (2019) indicate that it is essential to follow four evidenced-based principles; 1. Personalised feedback should be student-centred 2. Feedback should be task-focused, self-referenced, and should identify next steps, 3. Avoid giving students feedback that compares them against their peers (normative feedback), and 4. Avoid making personalised feedback about the student's character. Turner et al. (2011) suggest that to help develop students' competence, the teacher's primary role is to promptly provide high-quality feedback to students. Additionally, the NSW Department of Education (2021) indicate that giving students feedback is crucial because it can contribute to student learning and achievement. The NSW Department of Education (2021) suggested that a bridge between students' current and desired learning forms when teachers provide frequent, constructive, and instructive feedback.

A necessary type of feedback that I thought to fit this study is the concept of emotional motivational feedback messages. I asserted that emotional motivational feedback messages are essential considering the context of the study because emotions are essential factors in learning since they affect students' successes (Burke & Pieterick, 2010; Meyer & Turner, 2006) and their motivation (Hannula, 2006). Students' emotions also provide teachers with clues about what is happening in the classroom during instruction (Meyer & Turner, 2006). Sarsar (2017) described emotional motivational feedback messages as messages that include motivational strategies and emotional content for motivating and encouraging students to learn more about a specific topic. Students receiving motivational feedback exhibit some level of emotional reactions (Burke & Pieterick, 2010), and those emotional reactions enable students to view feedback as a personal message that makes it a powerful tool to keep them motivated to learn (Kim & Keller, 2008). From a social cognitive perspective, providing personalised feedback to students by their educators is vital as it forms part of the environmental factors that influence students' thinking and behaviour; that is, the development of students' academic competency.

Stemming from the provision of feedback, Turner et al. (2011) suggest that teachers must let students know that mistakes are informational to get them to develop their academic competency. Metcalfe (2017) suggests that "Learning about what is wrong may hasten understanding of why the correct procedures are appropriate" (p.468). In addition, Metcalfe (2017) suggested that the nature of errors made by students when learning can provide teachers with valuable information on what type of misconceptions students may hold about learning. This is important as Metcalfe (2017) continued to assert that errors show specific areas of difficulty, misconceptions for students and reveal to teachers students' thinking processes which can help teachers focus on learning aspects of learning that need to be clarified. In addition to teachers giving feedback and clarifying any misconceptions that may occur when students make errors or mistakes on academic tasks, students also feel a sense of disequilibrium, and that makes them want to learn. Van Loon et al. (2015) confirm that when individuals find out they made errors in learning and are wrong, they have increased attention to refutation. Therefore, this links to the social cognitive theory, highlighting the importance of students being aware of their strengths and limitations in the learning environment (Bandura, 1991). Bandura (1991) stated that "People cannot influence their motivation and actions very well if they do not pay adequate attention to their performances…and the immediate and distal effects they produce" (p.250). Bandura (1991) continued to explain that students learning from mistakes is natural and is part of the learning process.

#### ***2.2.1.2. Helping Students Reflect on What they Do and Do not Understand and Why***

Researchers such Dekker-Groen et al. (2013) have defined reflection as a process of thinking about and interpreting situations, events, experiences, and emotions, aimed at critically analysing decisions, actions and effects to learn from them. Turner et al. (2011) state that by reflection on the feedback provided by their teachers, students can further develop competency. When students reflect on their learning, researchers have found that those students are better able to be engaged in the learning process and participate in more in-depth and rich discussions during their class (Bogo et al., 2013; Turner et al., 2011). Turner et al. (2011) indicated that "…by helping students reflect on what they do and do not understand [their misconceptions] and why teachers can make them aware of their growing competence and more inclined to increase effort." (p.720).

Researchers have pointed out that when students reflect on what they do and do not understand and why, and this leads to them working harder to succeed (Schunk, 1995). Watkins and Marsick (1992) assert that the reason for this hard work to succeed amongst students after the feedback-reflection process is because students become more aware of their learning as they reflect, and this propels them to want to work harder at academic tasks. Zimmerman (2013) confirms that when students engage in reflections on their performances, this influences their thought processes and beliefs, leading to more subsequent efforts to learn.

#### *2.2.1.3. Scaffolding to Develop Students' Academic Competency*

Another way education researchers suggest that students' competency can be developed is by offering students scaffolding or assistance during learning (Turner et al., 2011). The concept of scaffolding and how it pertains to this study was explained in Section 2.1. of this chapter.

In this research, developing students' academic competency in science is of critical importance since students may demonstrate varying levels of competence and motivation for learning science. Therefore, based on the research, students' academic competency in various science concepts was explored as one of the factors that could impact the pre-service teachers' theory of action about strategies to motivate students for learning science.

### 2.2.2. Fostering Belongingness in the Classroom

Turner et al. (2011) define belongingness as "The human need to be an accepted member of a group and to have strong, stable relationships with others" (p.721). Kowalski (2018) asserted that belongingness is also referred to as connectedness or relatedness and has been one of the most recommendations for improving student motivation to learn. The social cognitive theory used in this study emphasises the importance of belongingness/connectedness (personal influences) as a condition for motivating persons (Bandura, 1993). This social cognitive perspective is aligned to the thinking;

learning occurs through social interactions, and motivation happens when students feel competent in the learning, which stemmed from previous physical and emotional environments which foster the development of belongingness (Bandura, 1993). Other researchers (e.g., Zumbrunn et al., 2014) are of the view that student belonging is associated with academic achievement. Studies have shown that secondary school students who receive a supportive academic climate and feel like they belong were more motivated (Anderman, 2003; Murdock et al., 2000) and felt more connected to their school (McNeely et al. 2002).

Science education researchers have found that fostering belongingness in the science classroom has motivated students to learn science, especially at the lower secondary school level (Strayhorn, 2018; Vaz et al., 2015). In the classroom, it is essential that science students feel as though they are part of the learning community to have deeper engagement in the science subject and be motivated to continue learning the intended learning outcomes (Feille et al., 2018). Feille et al. (2018) continue to purport a shared emotional connection, influence and needs satisfaction when a student feels as though they belong to a community. Furthermore, studies with secondary school students show that students who feel as though they belong and support in their academic journey were more motivated to learn because they felt more connected to their school (Anderman 2003; McNeely et al. 2002; Murdock et al. 2000; Zumbrunn et al., 2014). Science teachers have been able to help students get a feeling of belonging in the classroom in several ways, such as encouraging group work and peer tutoring during classroom learning activities, showing students that they care about them and engaging in storytelling.

#### *2.2.2.1. Cooperative/ Collaborative Group Work and Peer Tutoring*

One of the main ways teachers foster belonging in the classroom is by allowing students to participate in cooperative/collaborative group work activities. Education researchers have conceptualised cooperative group work as a teaching strategy that promotes student achievement and socialisation (Baines et al., 2007; Forslund et al., 2014; Oliveira & Sadler, 2008). Collaborative group work has been conceptualised as an important to approach learning where students' abilities are highlighted along with their shared responsibilities in the learning environment and cooperation (Fujita et al., 2021, Panitz, 1999). Moreover, researchers have indicated that when students interact with each other and share ideas during group work, they can better construct new understandings and clarify ideas by using language to explain issues (Webb & Mastergeorge, 2003). Furthermore, Gillies (2003) asserts that students are more motivated to achieve when they work in groups. Van Ryzin and Roseth (2019) stated that "…group-based learning activities can increase social opportunities for youth and provide a mechanism by which socially marginalised youth can develop positive relationships with more pro-social peers" (P. 2). The conceptions of cooperative/collaborative group work are critical to my study as it points to the interdependence of students on each other and the teacher to be motivated to learn by encouraging good emotional connections and building a sense of social responsibility in the classroom.

The other strategy for fostering belongingness, peer tutoring, is conceptualised by education researchers as a learning method involving the creation of peers to establish an asymmetric relationship, having a common objective that is achieved based on a relationship framework that is planned by the classroom teacher (Duran & Monereo, 2005; Moliner & Alegre, 2020). Based on the definition of peer tutoring, it can be noted that, like cooperative group work, peer tutoring fosters the development of a relationship where students would be most likely to cultivate s feeling of belonging with each other and the teacher.

I had already mentioned in this Section that the use of cooperative/collaborative group work as a strategy to motivate students for learning science needs to be planned carefully, taking into consideration all aspects of the classroom, including time available for instruction, the seating arrangements if the students, their prior knowledge, their grade level and backgrounds and most importantly the number of resources available so that every student is engaged while performing group work.

#### *2.2.2.2. Caring for Students*

Giving students a feeling of belongingness in the classroom can also be fostered when teachers show students that they care about them (Turner et al., 2011). Bouchard and Berg (2017) assert that when "Teachers care for and value and support" their students as well as when teachers respect, encourage and listen to students, students can feel a sense of inclusion in the classroom and thus be motivated to learn. In the context of this study, I will uncover how by using caring acts and being respectful as sub aspects of belongingness, the pre-service teacher can help students become motivated to learn science.

A critical way by which teachers can show that they care for students is by creating a warm socio-emotional tone in the classroom. Kowalski (2018) argues that there is a warm socio-emotional tone when a culture of belongingness is developed in the classroom. This warm socio-emotional tone promotes student positive self-efficacy and helps enhance their motivation for science learning via opportunities for vicarious experiences, encouragement, and support from teachers or peers (Bandura, 1993; Vygotsky, 1978).

#### *2.2.2.3. Engaging Students in Storytelling*

Another strategy that teachers can use for fostering belongingness in the classroom is by engaging in storytelling. Researchers such as Fawcett and Fawcett (2011) and Ochs et al. (1992) have identified storytelling as one of the most potent forms of teaching, which has been used to teach persons about customs and traditions of a people long before written histories were kept. This assertion by Fawcett and Fawcett (2011) suggests that by telling stories, persons can learn vicariously through social interactions with the storyteller. Therefore, this social interaction and vicarious learning experience are perceived as forming part of the environmental factors of the triadic reciprocality model of the social cognitive theory. Moreover, Fawcett and Fawcett (2011) suggest that when stories are told in the classroom by the teacher, this brings life to the lesson and helps students become further motivated to grasp the intended learning outcomes.

Furthermore, Alterio and McDrury (2003) have indicated that when persons tell stories, they share experiences and context that helps accommodate diverse realities and perspectives on a given topic. This sharing of experiences may have the added benefit of helping students feel as though they belong in the classroom, especially if they can connect the stories to their own cultural experiences to create a sense of self-awareness (Alterio & McDrury, 2003).

Bouchard and Berg (2017) conclude and reasserts the importance of fostering belongingness in the classroom to motivate students by adding, “If education is primarily about human beings who are in relation with one another, then schools have a unique opportunity to fulfil this fundamental human motivation” (p. 132). Once again, this quote by Bouchard and Berg (2017) highlights the importance of fostering belongingness in the classroom setting by encouraging students to form relations with each other.

### 2.2.3. Giving Students Autonomy in the Classroom

Turner et al. (2011) stated that teachers giving students autonomy in the classroom refers to any activity that students partake in that is self-initiating, and students’ actions are freely chosen, endorsed as valuable to the learning task, and the task/action is consistent with their values or needs. It can be argued that developing students’ autonomy is the most critical component of developing student motivation for learning (Deci & Ryan, 2000). Deci and Ryan (2000) conceptualised autonomy as the ability of a student to self-regulate his/her actions in the learning environment to facilitate the learning of intended learning outcomes. In 1994, Deci et al. suggested that three main conditions were needed to be met for a student to feel autonomy in the classroom:

1. Providing a meaningful rationale for the use of autonomy; Verbal explanations to help others understand the utility value of self-regulation

2. Acknowledging negative feelings; Acknowledging tension when it occurs.

3. Using non-controlling language; This is using communications that minimise pressure.

In 2004 Stefanou, et al. pointed out that autonomy support in the classroom can be shown by.

1. Organisational autonomy: allowing students to make decisions in the management of the classroom.

2. Procedural autonomy: offering students choices on how to present ideas in the classroom

3. Cognitive autonomy: allowing students the opportunity to evaluate their work.

Although giving students autonomy is critical to ensure that they are motivated to learn, Turner et al. (2011) recognise that it can be difficult for teachers to understand how to give and accept allowing students autonomy in the classroom. The main reason for this apprehension is because teachers fear sharing control and also fear that giving students autonomy will lead to off-task behaviours (Barrett & Boggiano, 1988; Turner et al., 2011). Furthermore, science education researchers (e.g., Jean-Baptiste et al., 2019 and Palmer, 2004) have asserted that pre-service teachers who have a low self-efficacy for motivating students are more apprehensive to giving students autonomy in the learning environment, and as such, those teachers' science lessons are more teacher-centred.

Deci and Ryan (2002) argue that when students are allowed to demonstrate autonomy in their learning, they are less anxious and can exhibit more positive coping strategies than a student who does not get the opportunity to be autonomous in the learning environment. Van et al. (2009) support this by saying students who are placed in highly independent learning situations stand a greater chance of being motivated to remain in school, engaged in the subject(s) being taught, and show high academic achievement. This research will uncover how pre-service teachers enact their beliefs about strategies for motivating students to learn science, considering that giving students' autonomy has been shown to motivate students.

Giving students autonomy in the learning environment also focuses on the use of un-controlling language by the teacher, sharing the rationale for teacher actions and allowing students to express negative emotions. Pertaining to the use of un-controlling language to support autonomy, when students are not directly told what to do in the classroom, they tend to feel more autonomous in completing their intended learning targets (Vansteenkiste et al., 2004). Researchers such as Black and Deci (2000) as well as Ryan and Connell (1989) suggest that this lack of controlling language in the learning environment, in turn, may allow students to be more motivated to learn. Moreover, Jang et al. (2010) assert that when autonomy supportive teachers "Provide explanatory rationales for requested tasks and communicate through messages that are informative, flexible, and rich in competence-related information, rather than neglecting rationales and by communicating through messages that are evaluative, controlling, pressuring, or even rigidly coercive" (p.589), students may be more inclined to be motivated to learn. Furthermore, concerning allowing students to express negative emotions, Jang et al. (2010) assert that when students do not get an opportunity while learning to express such emotions, they tend to be demotivated to learn, disengaged and give up easily on academic tasks in the face of difficulty.

### 2.2.4. Making Learning Meaningful

Meaningfulness is referred to as significance, purposefulness, or value that students place on their learning experience (Turner et al., 2011). Turner et al. (2011) stated that teachers could make learning meaningful to students by making learning relevant to students' lives after getting to know students and how they learn and having discussions and conversations with the students during instruction.

#### *2.2.4.1. Making Learning Relevant to Students' Lives*

First, learning can be made meaningful when students are able to relate to the concepts being taught in their lives. Science education researchers such as Jean-Baptiste et al. (2018) reveal that when students can relate concepts being taught to their lives, learning becomes meaningful to them, and thus they are more likely to develop a long-term interest and motivation to learn science. Ausubel (1968) propositioned those new concepts must have meaning to students, and students need to possess the relevant prerequisite knowledge to build on for learning to occur in a meaningful way.

Prinski et al. (2018) conceptualised relevance as being on a continuum which begins with i) personal association; that involves the perception that an object is connected to another object or a memory and moves to ii) personal usefulness; which takes into consideration that a stimulus can be used to fulfil an important personal goal and ends with iii) identification which is the incorporation of the stimulus to the individual's identity. Along the continuum, Prinski et al. (2018) suggested that personal meaningfulness increases more when an individual is able to relate to a concept.

In the Australian secondary school context, science teachers are expected to make science learning meaningful to students by relating concepts to students' lives. Therefore, teachers are encouraged to make science meaningful by relating the science information and content to students and facilitating science to allow students to have rich and relatable experiences concerning real-life events (Goodrum, 2019). Moreover, Bybee (1997) developed a 5E teaching model to help science teachers effectively organise their science lessons and facilitate science learning in a meaningful way. Goodrum (2019) indicates that this model was comprised of 5 interconnected phases that include engaging students by stimulating their interest in an activity, helping students explore concepts, offering explanations of concepts, students elaborating on explanations by applying what they have learnt, and finally, students evaluate what they have learnt.

#### *2.2.4.2. Knowing Students and How They Learn*

Another way pre-service teachers can make learning meaningful to the students is by getting to know the students and how they learn. Mestre (2006) asserted that it is essential for teachers to know their students and build on their strengths: Use the strengths that students bring to the classroom. Education researchers such as Schunk et al. (2012) claim that teachers must consider students' interests, background (cultural or otherwise), knowledge and abilities when preparing learning experiences for them to foster inclusion in the classroom and motivate them to learn the intended learning outcomes.

Getting to know students and how they learn is essential, mainly because it is the first standard in the Australian Professional Standards for Teachers (AITSL, 2011). In this first standard of the Australian Professional Standards for Teachers document, there are six focus areas which include.

a. Physical, social, and intellectual development and characteristics of students
b. Understand how students learn
c. Students with diverse linguistic, cultural, religious, and socioeconomic backgrounds
d. Strategies for teaching Aboriginal and Torres Strait Islander students
e. Differentiate teaching to meet the specific learning needs of students across the full range of abilities
f. Strategies to support full participation of students with disabilities

Within this standard, it can therefore be seen that teachers should have a holistic understanding of students' backgrounds (cultural or otherwise) and students' development. Moreover, the focus areas under this standard suggest that teachers should be prepared to meet the specific learning needs of students by engaging in differentiated teaching. Meeting the specific needs of learners in the context of education and learning is commonly referred to by education researchers as understanding students' learning diverse learning needs (Mestre, 2006; Pashler et al., 2008).

The research literature gives ample evidence to highlight that knowing students and their learning needs are essential to pre-service teachers when formulating their beliefs about strategies for motivating students to learn. Knowing students' diverse learning needs leads to a more student-centred approach to teaching and encourages differentiated instruction by the science teacher. Researchers, for example, Danzi et al. (2008), have stressed the importance of using differentiated instruction to decrease student boredom, student frustration and improve student motivation in the classroom. Dinescu et al. (2011) conceptualised differentiated instruction as a broad term encompassing various classroom practices that cater to differences in students' interests, social needs, and prior knowledge. It is therefore easy to see that concerning science teaching, the findings of this study bear similarity to the conclusion of other studies, for example, Dinescu et al. (2011), in highlighting the importance of differentiated instruction to making science learning meaningful to students and motivate them for learning science.

This understanding that teachers should get to know their students is further tied into the understanding by education researchers (Mestre, 2006; Pashler et al., 2008) that every student is unique in the way that he/she learns and therefore requires a unique/ differentiated approach to instruction ensuring that students learn; hence the concept differentiated instruction. Additionally, Fisette (2010) also state that the main goal in teachers getting to know their students is "to inform and differentiate their instruction to meet their need and enhance learning opportunities" (p. 43).

#### *2.2.4.3. Having Discussions and Conversations with the Students During Instruction*

A final way by which teachers can make learning meaningful to students is by having discussions and conversations based on the concepts being taught (Turner et al., 2011). Brophy (2013) is of the view that discussion in the classroom allows students the opportunities to engage in verbal interaction about a topic. Palmer (2007) suggested that discussions are essential in the science classroom as it allows students to integrate new information about concepts being taught into their schemas. This assimilation of new information can serve to cause disequilibrium in the students' cognition and thus motivate them to want to learn to restore equilibration of concepts.

In this study, how pre-service teachers use strategies that they consider meaningful to students to motivate them for learning science in a meaningful way will be uncovered.

## 2.3. Chapter Summary

In this thesis, my main aim was to investigate the factors influencing pre-service teachers' theory of action about strategies to motivate students for learning science at the lower secondary school level. The social cognitive theory (Bandura 1977) coupled with the four principles of motivation (Turner et al. 2011) have been presented as suitable theoretical lenses for analysing and interpreting the data gathered for this study despite the absence of scholars using this framework to investigate the phenomenon of pre-service teachers' theory of action.

The social cognitive theory is adopted as the overarching theoretical lens for this study's analytical framework. In this research, I viewed the triadic reciprocality model of the social cognitive theory as essential to inform the interpretations of the data gathered in this research. Within the personal factors of this model, the concept of observational learning focused on how students learn by them paying attention to the behaviour exhibited by a person who models the desired behaviour. The social cognitive theory allows for examination of the factors that influence pre-service teachers' theory of action about motivating students to learn science because some of those factors may be based on the pre-service teachers' observations of other teachers teaching during their professional experience placement. According to observational learning, when pre-service teachers pay attention to other teachers who teach and observe them, they adopt procedures for retaining and producing a successful observed behaviour.

Additionally, the concept of scaffolding was considered as part of the personal/ cognitive factor, as part of the triadic reciprocality model and therefore considered by me as fitting for interpreting and analysing the data gathered in this thesis. When pre-service teachers are given moment to moment verbal scaffolding by their supervising teachers and other teachers and prepare the instructional frameworks by planning their lesson and instructional strategies for teaching, students can be motivated to learn science. During the initial teacher education program, pre-service teachers receive scaffolding through many sources, such as their supervising teachers and peers. This support is gradually removed to allow them to be more independent as they can enact their beliefs about strategies for motivating students to learn science. This element of scaffolding is vital to this study as it provides a lens through which the data can be analysed and interpreted

The second aspect of Bandura's triadic reciprocality model was the environmental influence on the pre-service teachers. Within this aspect, there is a focus on social norms and the physical environment which interacts with individuals to influence their beliefs and actions. In this study, I considered those factors when interpreting the findings of this study. As well as social interactions with others, many other factors influence the development of pre-service teachers' espoused theories and how those espoused theories are enacted to motivate students for learning science.

The second central theory informing this study's analytical framework was the four principles of motivation described by Turner et al. (2011) as a cross-section of the four major perspectives of motivation. Examining the study's data through the lens of these four principles, competency, belongingness, autonomy and meaningfulness, allows for an interpretation and understanding of the data gathered on how pre-service teachers' espoused beliefs are ultimately enacted to motivate science students in the context of their professional experience placement.

In the next chapter, I reviewed the existing literature on teacher beliefs, including their origin, in the context of pre-service teachers. Moreover, I critically examined relevant literature on student motivation for learning science and strategies pre-service teachers have found to motivate students for learning science at the lower secondary school level.

# Chapter 3

# Literature Review

## Introduction

In the previous chapter, I presented the analytical framework for this study. This framework combined aspects of social cognitive theory and principles of motivation relevant for analysing and interpreting the data gathered in this thesis.

In this chapter, a critical analysis of the literature concerning the study's central concepts is examined to understand better the phenomenon being researched and address gaps present in the existing literature. This study's central focus is on how pre-service teachers develop their beliefs about and strategies for motivating students at the lower secondary school level to learn science. This study builds on the views of researchers such as Argyris and Schon (1974), Pajares (1992), Richardson (1996), Ibrahim (2003) and Irez (2007). They hold the view that teachers' beliefs about the instructional processes and pedagogical practices influence the classroom teacher's instructional decisions and actions.

Due to the nature of the phenomenon being investigated in this thesis, it was necessary to explore the literature for information concerning the origin and conceptualisation of teachers' beliefs: the development of teachers' beliefs, teachers' changing beliefs about teaching and learning, and teachers' beliefs about the nature of science teaching and learning. The literature on student motivation for learning science, effective pedagogies for motivating science students, and the role of initial teacher education programs in science are also critically examined in this chapter.

## 3.1. Teacher's Beliefs about Learning and Teaching

One of the impetuses for this research is the notion expressed over the years by both in-service and pre-service teachers that teachers hold varying degrees of beliefs about their learning science and their pedagogical prowess (Palmer 2008). This variation in teacher beliefs has also been noticed by researchers who have tried to understand how teachers use strategies to motivate science students (Brothy, 2013; Palmer, 2007; Windschitl et al., 2020). In Australia, a report on students' performance in science by the Office of the Chief Scientist (2014) claims that students' motivation to learn science is declining, especially at the lower school level. Although there are many reasons why this decline in student motivation exists at the lower secondary school level, the Office of the Chief Scientist (2014) suggest that one of the ways in which this issue of students' declining motivation for science can be addressed is via an increased focus on teachers' thought processes /beliefs.

### 3.1.1. Origin and Conceptualisation of Teachers' Beliefs

Teachers' beliefs concerning instruction have been among the most researched educational research subjects from the 1980s (Samuel & Ogunkola, 2015; Voet et al., 2019). Many education researchers have attributed the rise in the focus on teachers' beliefs and cognition to the expansion of research paradigms that occurred in the late 20$^{th}$ Century (Alexander & Dochy, 1995; Fang, 1996). By the 1980s, Ravich (1990) claimed that the U.S. education system had a series of adverse reports that pushed educators and researchers to investigate the possible influences of teachers' beliefs on learning and pedagogical strategies used in the classroom. Education researchers continued to attribute that the focus on teachers' beliefs and shift in social psychology in the late 20$^{th}$ century was due to a change from an affective to a cognitive orientation (Richardson, 1996).

This shift to the cognitive orientation brought to light the importance of teachers' cognition in the teaching process.

Researchers such as Schon (1983) and Clark and Peterson (1986) suggested that not only should teachers' cognition be investigated, but teachers' beliefs about the nature of learning and teaching should be converted into action to become theories-in-use. Clark and Peterson (1986) continued to classify the teaching process into two major domains: (1) teachers' thought processes and (2) teachers' actions and their observable effects. This classification of the teaching process by Clark and Peterson (1986) clarifies that teachers' beliefs should be an integral part of the teaching-learning process to inform pedagogical practices and learning in the classroom.

An individual's belief system is defined as a set of psychologically-based understandings, premises and propositions that an individual has about the world that he/she feels to be true (Richardson, 1996). Humans are born with their senses to assimilate and accommodate data from the environment about phenomena. People can adapt information received from the natural and social world into their cognitive schema to develop their belief systems. This definition illustrates that one's belief about phenomena is of paramount importance to his/her social-cognitive development. However, the aforementioned definition of belief suggests that the term connotes those beliefs involve more than just developing one's understanding or perceptions about phenomena. The definition of belief means that it is a human trait and consists of a person's beliefs and trying to differentiate himself from the world by finding and developing systems of meanings about events occurring in the environment, natural or human-made (Samuel & Ogunkola, 2013).

The question now arises as to how beliefs compare with other cognitive processes of individuals. Over the years, many researchers have investigated the nature of beliefs and knowledge (Alexandra & Sinatra, 2007; Boldrin & Mason, 2009; Nespor, 1987; Nisbett & Ross, 1980; Pajeres, 1992). Some of those researchers, for example, Boldrin and Mason (2009), conceptualised knowledge as being composed of an evaluative component, whereas other researchers purport that beliefs are formed due to an affective process (Nespor, 1987; Pajeres, 1992). Some other researchers believed that knowledge was a cognitive outcome of thought, and a persons' belief was the affective outcome of his/her thought processes (Halpern, 2013). Samuel and Ogunkola (2013) support this idea by Halpern (2013) by claiming that beliefs are uncertain and unproven personal truths that objective evidence may not support.

Samuel and Ogunkola (2013) also claim that there is a line of thought in which beliefs and knowledge are regarded as being indistinguishable because both concepts a justified "According to objective, rational criteria [and] may also have subjective, affective and evaluative components" (p. 45). Moreover, Boldrin and Mason (2009) proposed that knowledge may involve the affective domain and that beliefs may also involve some level of cognition. This preliminary literature about the conceptualisations of beliefs is important because of how and what teachers think about teaching shapes their theories-in-use about strategies for motivating students to learn science.

From this discourse on the conceptions of beliefs, it may be understood that the concept of belief is difficult to conceptualise. It can be noted that although the concepts, beliefs and knowledge may be difficult to operationalise, researchers have agreed that both concepts are not independent of each other, nor are they independent of the wider natural and social world (Tondeur et al., 2017). As such, Richardson's (1996) definition of beliefs as a set of psychologically-based understandings, premises and propositions that an individual has about the world will be adopted as the primary definition throughout this study. Moreover, as it pertains to this study's topic, the definition of beliefs provided by Fang (1996) being, a person's construction of reality they think as being accurate enough to guide their thoughts and behaviours, will be considered to provide an additional bearing for this research. Kagan (1992) argues the study of beliefs is critical to education by asserting that "…the more one reads studies of teachers' beliefs, the more strongly one suspects that this piebald of personal knowledge lies at the very heart of teaching" (p. 329).

### 3.1.2. Development of Teachers' Beliefs

There have been various researchers who have investigated how teachers' beliefs about the teaching-learning process develop (Basckin et al., 2021; Leavy et al., 2007; Richardson, 1996). Those researchers have examined the evolution of teachers' beliefs in various ways, considering factors such as teachers' personal experiences from their schooling and instruction and teachers' cultural influences (Richardson, 1996). A critical reason cited in the literature for the attention given to teachers' beliefs is that teachers' beliefs about the teaching-learning process may determine their theories-in-use in the classroom (Omare et al., 2020). However, researchers have provided different interpretations of how those factors have influenced the development of teachers' beliefs about the teaching-learning process (Basckin et al., 2021; Leavy et al., 2007; Waters-Adams, 2006). Langcay et al. (2019), for example, conducted a study about the epistemological beliefs of 181 pre-service teachers in the Northern Philippines. They carried out this study through the lens of the five dimensions of knowledge; the stability of knowledge, structure of experience, source of knowledge, ability to learn, and speed of learning. Langcay et al. (2019) found that pre-service teachers' beliefs vary along with their ethnicity, sex, and program specialisation. The results of the research by Langcay et al. (2019), therefore, lead to the more general question; that also pertains to the study of beliefs in this research, what are the pre-service teachers' epistemological beliefs? The term epistemological beliefs, coined by Perry (1968), refer to how a person conceptualises the nature of knowledge and from where it comes. In this study, I indicated that epistemological beliefs could be a factor influencing the pre-service teachers' espoused theory about strategies for motivating students to learn science.

Yilmaz (2011) postulates that teachers' beliefs had been affected by their teachers, making them teach accordingly. Yilmaz suggests that in the early years of teaching, a teacher's epistemological beliefs about teaching are critical and determine how he/she conceptualises the teaching-learning process. Cain's (2009) views are similar to Yilmaz (2011) in that pre-service teachers' overall beliefs about the teaching and learning process can be traced back to their episodic memories of how they were taught/schooled themselves. Samuel and Ogunkola (2015) continue to assert that: "Teachers' beliefs may be strongly influenced by images of behaviours of favourite teachers" (p. 30).

Plourde (2002) researched some of the factors that may influence the development of pre-service teachers' beliefs about student learning and science teaching. Plourde found that the main factors influencing how pre-service teachers develop their beliefs were: an overall focus on summative assessments and a lack of performance assessments, the overall emphasis on textbooks and lectures for science teaching, insufficient involvement in practical or activities during science lessons at the elementary through to tertiary education, and a poor attitude toward the teaching of science by their in-service mentor teachers. From Plourde's research, it was concluded that some of the factors that influenced the development of pre-service teachers' beliefs fell in line with the traditional epistemological belief of instruction as well as the more modern constructivist and inquiry-based epistemological belief of teaching science. Similarly, to the study by Plourde (2002), in this research, I aim to conduct in-depth analyses of the types of factors that may influence the development of pre-service teachers' beliefs.

Yilmaz (2011) is of the view that pre-service teachers who hold traditional epistemological beliefs engage in didactic teaching methods and act as the information dispenser to students. On the contrary, Yilmaz (2011) suggests that pre-service teachers who have constructivist epistemological beliefs believe that students should be interacting with each other and be active participants in formulating their systems of meaning during the learning process. Pre-service teachers' epistemological beliefs are important as those beliefs determine what they understand as being appropriate pedagogical practices that should be used in the class during the teaching of a particular topic (Kırmızı & Sarıçoban, 2021).

One suggested idea that has been widely researched amongst education researchers is that teachers' beliefs about strategies for motivating students to learn may have begun developing from their previous experiences as secondary school students. For instance, in research on what shapes the way teachers teach, conducted by Oleson and Hora (2014), they found out that teachers' belief systems are heavily influenced by how they were taught as students. Moreover, Lortie (1975) theorises that teachers belief systems begin during their time as a student. However, Nespor (1987) asserts that students do not consciously intend to mimic their teachers but rely on implicit episodic memories to provide them with an accessible bank of strategies for teaching when they become teachers themselves. This subconscious implicit aspect is experienced, which contributes to teachers' beliefs about their pedagogical practices, is important it may be the starting point for pre-service teachers' beliefs.

There is abundant research showing that pre-service teachers' pedagogical beliefs strongly influence their classroom practice (e.g., Tondeur et al., 2017). Pajares (1992) concluded that it is vital that initial teacher education providers consider pre-service teachers' beliefs throughout their programs.

### 3.1.3. Teachers' Beliefs About Science Pedagogy for Motivating Students

There has been a large amount of literature on teachers' beliefs about various pedagogies for teaching science. This is important since Pajares (1992) suggest that teachers' beliefs are critical as those beliefs may consequently determine the types of pedagogies that teachers may use to motivate students to learn. Tondeur et al. (2017) described teachers' pedagogical beliefs as a system comprised of complex, multifaceted structures of other related beliefs about teaching and learning. Those belief systems "are formed over many years of experience, beginning with life as a pupil in the classroom and extending to a variety of professional contexts teachers encounter" (Prestridge, 2017, p. 368). Tondeur et al. (2017) further posit that teachers' pedagogical beliefs refer specifically to their understandings about teaching, premises and propositions about the teaching and learning process that they believe to be true. According to Peterson et al. (2018), pedagogical beliefs serve as a framework for all the decisions teachers make about how they teach. Wieduwilt et al. (2021) suggested that pedagogical beliefs represent beliefs regarding pedagogical experiences that can be either general or domain-specific and, therefore, can be studied within the contextual framework of the pedagogical approach themselves. Wieduwilt et al. (2021) also suggested that pedagogical beliefs also encompass different types of knowledge on designing and sharing effective learning processes and implicitly guiding teachers' actions in the classroom.

A study that was found to have essential information about pre-service teacher beliefs about science pedagogy and therefore considered valuable to this study is the study by Nida et al. (2021). In this study, sixty-two secondary science pre-service teachers teaching at the lower secondary school level were invited to participate in a qualitatively analysed survey. Nida et al. (2021) found that pre-service teachers believed that teaching strategies that can be used for science instruction are dependent on many factors, with some being the relevance of the strategy to the student's personal and social domain, teacher expertise in using the pedagogy, curriculum constraints and the lack of necessary student skills. The study by Nida et al. (2021), although conducted in the context of socio-scientific issue-based science learning, bears similarities to how I will conduct this current research. My study uses a qualitative approach using a survey, similarly to Nida et al. (2021), to gather data about pre-service teachers' beliefs about strategies used in the science class to motivate students to learn science from a social cognitive perspective comprising of observational learning.

Similar to epistemological beliefs, pedagogical beliefs are of particular relevance to education. On one hand, teachers' understandings about the nature and origins of knowledge and their belief systems may most likely strongly influence their pedagogical practices. On the other hand, teachers' understanding of pedagogy would most likely affect how they conceptualise the teaching-learning process. It is, therefore, most likely that the types of pedagogical practices employed in the classroom may be as a direct result of teachers' beliefs about the practices that they should use, which developed as a result of their governing epistemological beliefs.

In science education, teachers' beliefs about science pedagogy have been commonly classified as either teacher-centred or student-centred beliefs (e.g., Deng et al., 2014). Prestridge (2017) suggests that a teacher who holds teacher-centred pedagogical beliefs believes that he/she is integral to the students' learning and that learning depends on pedagogies presented to students. On the contrary, a teacher who holds student-centred pedagogical beliefs about the teaching-learning process focuses on student engagement during science instruction (Al-Balushi et al., 2020).

### 3.1.4. Teachers' Beliefs About the Nature of Science Teaching and Learning.

Based on the examination of teachers' pedagogical beliefs in the previous Sections, it can be reasonably assumed that pre-service teachers' beliefs about teaching and learning science at the lower secondary school can be an essential determiner of the teachers' actions in the classroom (Tsai, 2002). Concerning pre-service teachers' beliefs about teaching, researchers such as Teo et al. (2008) have classified those beliefs about the nature of science teaching into two main categories:

1. Teaching as a process of knowledge construction
2. Teaching as a process of knowledge transmission

Teo et al. (2009) went on to say that these two beliefs about teaching may not necessarily be independent of each other but "…may form a continuum of positions that teachers adapt depending on the contexts and how teachers view the contexts" (p. 353). Therefore, this indicates that there may be no one pedagogical approach that a specific science teacher may use solely during his/her career as a science teacher in the teaching of science.

Researchers have explored pre-service science teachers' beliefs about teaching and learning. Richardson (1996) points out that beliefs about science learning and teaching represent what an individual perceives as accurate. Only after considering the factors mentioned earlier can pre-service teachers be effectively prepared and equipped with the appropriate beliefs, e.g., epistemological or pedagogical, attitudes, and self-efficacy beliefs necessary to teach science effectively. Moreover, Kazempoura and Sadler (2015) indicated that the pre-service science teachers' beliefs, attitudes, and self-efficacy about teaching science are interrelated. Kazempoura and Sadler (2015) also suggested that to understand pre-service teachers' beliefs about the nature of teaching and learning; pre-service teachers should always be focusing on the following three domains; pre-service teachers' prior science learning experiences, their affective and cognitive experiences during their ITE program, and any factors that may influence their beliefs about the nature of teaching and learning. This revelation by Kazempoura and Sadler (2015) bears weight on this study as it provides me with a way to understand factors influencing pre-service teachers' theory of action about strategies for motivating students to learn science during their professional experience placement.

Of further relevance to teachers' beliefs about the nature of teaching and science learning are teachers' beliefs about the subject, science itself. Many researchers have studied the influence of teachers' beliefs about science and the teaching and learning of science and found that consensus amongst the science education community is that the development of positive beliefs and attitudes toward science contributes to scientific literacy (National Research Council, 2012). The National Research Council (2012) expressed the notion that science teachers' beliefs and attitudes about science should be viewed as integral components of science instruction.

Science teachers' beliefs and attitudes have influenced students' attitudes toward learning and achievement in science (Britner & Pajares, 2006; Turkmen, 2008). For example, a science teacher who has demonstrated significant interest in and appreciation for science is more likely to be motivated to teach science to facilitate the nurturing of students' natural curiosity for learning science motivates students to learn. In contrast, researchers have shown that there has been a positive correlation between science teachers who espouse negative beliefs and demonstrate negative attitudes toward teaching science and the science students' low academic achievement in the subject (Tosun, 2000; Wenner, 1993).

Although pre-service teachers' beliefs about teaching science have been studied extensively, work that focuses specifically on secondary science pre-service teachers and how their beliefs may change in the context of their teacher education programs, especially during their professional experience placements, is rare. Equally elusive is research that focuses on the discrepancies that may exist between secondary science pre-service teachers' espoused theories on how to motivate science students at the lower secondary school level and their theory-in-use (Mansour, 2013). Research has shown that generally, if there is any disparity between pre-service teachers existing beliefs and the instructional methods which they receive during their initial teacher education (ITE) programs, then this experience may lead to the pre-service teachers developing traditional and ineffective teaching practices (King et al., 2001; Pajares, 1992;). Palmer (2007) also expressed the view that pre-service teachers' beliefs usually are unaddressed during their ITE programs, although the ITE programs are essential to allow pre-service teachers to change their beliefs about science and science teaching and develop their strategies to motivate science students.

### 3.1.5. Teachers' Changing Beliefs About Teaching and Learning

A critical reason cited in the literature for the attention given to teachers' beliefs is that they can be subject to change even though some researchers claim that those beliefs are resilient to change (Richardson, 2003, Samuel & Ogunkola, 2015). This brings up important questions; to what extent are teachers' beliefs resilient? And what would cause teachers' beliefs to change over time? Rokeach (1976) advanced the notion of strength and stability of beliefs based on its position in the teachers' belief system. Rokeach (1976) posited that the more central a belief is to an individual's central/peripheral dimension, the more resistant that belief would be to changing. Richardson (1996) suggested that those beliefs about science learning and teaching could change as a result of "conversion or gestalt shift" (p. 321). Richardson (2003) explained that pre-service teacher beliefs are generally loosely formed, highly idealistic, deeply seated and traditional at the point of entering a teacher training program.

Several studies have demonstrated how pre-service teachers' beliefs can change. Wilkins and Brand (2004) found that there was a positive relationship between the pre-service teachers participating in their [Math] methods courses and a change in their beliefs and attitudes towards the learning and teaching of Mathematics. In a similar study, Richardson and Kile (1999) found that as pre-service teachers progress through their ITE programs, their beliefs changed from being traditional to the development of a more constructivist approach to learning.

Moreover, another study that examined the change of teacher beliefs was conducted by Soysal and Radmard (2018), where they used a case study design to investigate the beliefs of three pre-service teachers from Bandura's social cognitive theory perspective that included the triadic reciprocality model of learning; which was discussed in chapter 2 of this study. Soysal and Radmard (2018) discovered that although the pre-service teachers entered the program with conventional and idealistic teaching beliefs, they improved their conceptualisation of the teaching-learning process after experiencing co-constructivist teaching. Therefore, it is likely that pre-service teachers' epistemological and pedagogical beliefs can change, which can be reflected in their classroom behaviour.

Another study of pre-service teacher change of beliefs was conducted by Kazempoura and Sadler (2015), who conducted a multi-case research project that explored changes in pre-service teachers' science beliefs, attitudes and self-efficacy. One of Kazempoura and Sadler's (2015) research implications pointed that the factors that can affect pre-service teachers' beliefs included the pre-service teachers' prior science learning experiences.

There is also considerable research indicating that it is challenging to change pre-service teachers' beliefs about teaching and learning. For example, Samuel and Ogunkola (2013) express the view that pre-service teachers who developed their beliefs about teaching during their schooling held persistent beliefs that are central to them. Thus, those beliefs may be resistant to change even during the period of their ITE program. In my study, closely examining the extent to which pre-service teachers claim that their beliefs about strategies for motivating students to learn science was vital. This is crucial because it helped uncover a deeper understanding of those pre-service teachers' beliefs about strategies for motivating students to learn science in the context of their professional experience placement. I provide evidence in chapters five and six to highlight how pre-service teachers' beliefs are changing or remaining rooted in their initial beliefs during and after their placement period.

Fives and Buehl (2010) posit that the best methods that researchers have used to investigate the changing pre-service teachers' beliefs have been through interviews and open-ended questions in questionnaires. The aforementioned methods of understanding how pre-service teacher beliefs were adopted in the context of my current research. Fives and Buehl (2010) further argue that the aforementioned methods have led researchers to develop an understanding of pre-service teacher beliefs about how their knowledge can change as a result of instruction, how this change in belief may influence their teaching practices, how this change in belief can vary depending on the context and how this change in belief can influence how and what they learn in their teacher education classes. In using similar methods of interviews and surveys, my study also undertakes in-depth approaches to understanding pre-service teachers' espoused theories and theories-in-use.

## 3.2. Student Motivation for Learning Science

Years of research on science education show that there is generally a decline in the numbers of students pursuing science and science-related subjects in high school and at the post-secondary school years (Musengimana et al., 2021; Zeyer, 2018; Awan & Sarwar, 2011; Office of the Chief scientist, 2014). Zeyer (2018) asserts that the main reasons for this decline are that students are not motivated and do not feel engaged enough in science classrooms. Furthermore, research has shown that even among students who pursue science subjects at school, there are considerable gaps in achievement at the secondary school level (Jackson & Ash, 2012; Johnson, 2009). The overwhelmingly significant gaps in science performance and motivation to learn and pursue science and science-related courses at school have resulted in increased attention to science education. Although the positive relationship between motivation and academic achievement is well documented in studies (Amrai et al., 2011; Baumann & Harvey, 2021; Gupta & Mili, 2017), evidence from many international studies has shown that secondary school science students continue to show a lack the interest and motivation to study science and science-based subjects (Fortus & Touitou, 2021; Liou et al., 2020; Muwonge et al., 2019). Moreover, other science education studies have revealed that student interest in and motivation for learning science declines significantly by age 15 (Bernacki et al., 2016).

However, the discipline of science education remains uninformed regarding how pre-service teachers can motivate science students at the lower secondary school level, especially during their professional experience placement period. Therefore, my study seeks to address this gap and add to the literature in a meaningful way by uncovering pre-service teachers' espoused theories and theories-in-use about strategies for motivating students at the lower secondary school level during their placement.

Students' motivation to learn science has attracted much attention amongst science education researchers over the past decade. For instance, researchers such as Vedder-Weiss and Fortus (2011), using the motivation construct achievement goal theory, examined whether adolescents' declining motivation to learn science in democratic and traditional schools in Israel was inevitable. They found that motivation for learning science was not unavoidable in either of the schools studied. The researchers suggested that adolescents' non-motivation to learn science in schools was primarily due to the school culture. This research has a direct bearing on my study because it allows me to examine potential school-based factors and others that may influence the pre-service teachers' choice of strategies for motivating students to learn science.

There have been many studies into the decline of student motivation at the secondary school level. One such study was conducted using a survey approach by Shin et al. (2018), who investigated secondary student science learning motivation in Korea and Indonesia. Shin et al. (2018) surveyed a total of 867 Korean science student and 954 Indonesian students during 2015-2016 and found out that the science learning motivational levels for Indonesian students was higher than the Korean students. It was concluded, however, that despite the results of their study, Shin et al. (2018) state that there still needs to be significant research into student motivation to learn science since the concept is "More complex than previously thought…. [and] means that the definition of the student science learning motivation is not a straightforward matter" (p. 3138). The latter statement further highlights that there have been varying views on whether motivation affects student performance in science.

## 3.3. The Link Between Student Interest and Motivation to Learn Science

Researchers such as Jean-Baptiste et al. (2019), Pressick-Kilborn (2015) and Walker et al. (2004) have established that there is a link between student interest and student motivation. Pressick-Kilborn (2015) and Walker et al. (2004) argued that interest develops when students engage in social interactions in learning communities. Furthermore, Pressick-Kilborn (2015) suggests that interest is part of a unique motivational variable and is considered as being a motivational construct. This would suggest for students to be motivated to learn, they would have to have a certain level of interest in what they are about to learn. In the context of this study, I agree Pressick-Kilborn's (2015) research and assert that students' interest in science is a necessary precursor that subsequently can lead them to become motivated to learn science.

## 3.4. Teachers' Beliefs About Motivation

Teachers' beliefs about motivation have attracted a lot of attention from education researchers over the past decade. This is so because it is fairly understood within the education community that the main aim of teaching is to motivate students for learning concepts specific to the subject being taught at the time so that students can become knowledgeable. It is not surprising, therefore, that education researchers such as Turner et al. (2009) claim that teachers hold a myriad of beliefs concerning the motivation that is mainly centred around "…curriculum, pedagogy, and student understanding and engagement" (p.368). Furthermore, Turner et al. (2009) argued that teacher beliefs about motivation are socially constructed as those beliefs are forged "…not only in the social contexts of classrooms but also in the school and community" (p. 368). This social consideration concerning motivation (discussed in Chapter 2 of this study) may mean that a teacher's belief about motivation may not be static but be subject to change based on the particular environment; that is, the students present; that is the possibly diverse backgrounds, their ability, what resources are present in the classroom and also the curriculum.

Conflicting this fluid aspect to motivation is the notion that teachers believe that students are directly responsible for their own motivation. Researchers such as Floden (1996) and Prawat (1992) hinted that teachers hold strong beliefs that if the subject content and students are fixed, the onus is on the student to ensure that they are motivated enough to learn what they are instructed to (Nuthall, 2004). This belief about the stability of motivation by some teachers may mean that teachers would believe that no matter what instructional strategies are used to teach a particular content, then they would not be able to motivate students. This focus on the student as the main driver of motivation was highlighted in research by Williams and Williams (2011), who pointed out that students are the first out of five ingredients for improving student motivation. Moreover, Williams and Williams (2011) stated that students bring varying degrees of both intrinsic and extrinsic motivation regarding their learning of concepts. Furthermore, Williams and Williams (2011) claim that,

> Intrinsic motivational factors found to be at work with most students include involvement (the desire to be involved), curiosity (find out more about their interests), challenge (figuring out the complexity of a topic), and social interaction (creating social bonds). Extrinsic motivational factors include compliance (to meet another's expectation, to do what one is told), recognition (to be publicly acknowledged); competition; and work avoidance (avoid more work than necessary). (p. 3)

This, therefore, raises the question as to whether teachers believe that there are pedagogies that are effective for motivating students to learn science at the lower secondary school level.

### 3.5. Effective Pedagogies for Motivating Secondary School Science Students

Teachers' choice of pedagogy to be used during instruction is informed by their beliefs about teaching and learning. Pedagogies used by teachers in the science classroom can have various purposes, with one of those being to motivate students for learning. Science education researchers have identified various pedagogies that have been used to motivate science students for learning science. Those pedagogies have come from multiple schools of thought outlining the nature of science, science teaching and motivation. Those researchers have made a case for the use of numerous approaches and pedagogies that stimulate science students' sense of motivation and inquiry.

Researchers have viewed Inquiry-based learning as an effective approach for motivating students to learn science (Bybee et al., 2008). In the 19th century, the scientific revolution led to a thrust for universities and schools to offer science as an area of study. This, therefore, led to an evolution of philosophical thought in science which further influenced technological advancements (Samuel & Ogunkola, 2015). One such approach that stemmed from the acceptance of science as an area of study by universities was the inquiry-based approach to science instruction proposed by Charles Elliot in the late 19th Century.

Bybee et al. (2008) traced the origin of a contemporary inquiry-based approach to science instruction to John Dewey in the early 20th Century. Dewey was not in support of the teacher-centred approach to science instruction and thus argued that science teaching should be inquiry-based, and there should be an emphasis on developing students' understanding of science processes, thinking, and reasoning skills. After Dewey's era, the new focus of science inquiry-based instruction gained new impetus by some researchers despite taking time to become widely adopted by others. Science researchers and educators were, and up to this day are generally unable to agree on a single conceptualisation of inquiry-based pedagogical practice (Anderson, 2002).

This lack of conceptualisation led to the inquiry-based approach to science teaching and learning as being viewed as an umbrella term, hosting a wide array of strategies that can be used to motivate and support science students' learning at the secondary school level. As a result of this lack of agreement, I thought it would be helpful to uncover what pre-service teachers' beliefs about strategies for motivating students for learning science are and what strategies are used to motivate students in the context of their professional experience placement.

Moreover, as part of the effective pedagogies for science teaching, researchers have added that the scientific approach has been the most common pedagogy used in modern times (Siayah & Setiawan, 2020). This pedagogical approach utilised by science teachers has been conceptualised as one where the focus is on student learning by iterative questioning, gathering evidence, and innovation (Handelsman et al., 2004). Additionally, Handelsman et al. (2004) stated that the scientific approach as a pedagogical strategy involved three main ideas: i) Active learning, ii) Assessment and iii) Diversity. Concerning my research, the most relevant concept was seen as being active learning which Siayah and Setiawan (2020) conceptualised as being "a process in which students are actively engaged in learning. This type of learning may include inquiry-based learning, cooperative learning, or student-centred learning" (p. 3). Furthermore, Siayah and Setiawan (2020) suggest that for a teacher to engage students in active learning, it was expected that a wide range of strategies could be used including, inquiry-based learning, group work (cooperative learning), peer instruction, problem-based learning. In my research, the pre-service teachers' theories-in-use concerning strategies for motivating students to learn science is investigated and presented.

Although researchers and science teacher educators may recommend the pedagogies needed to facilitate learning and motivate science students differently, in Australia, the Australian Science Curriculum (2016) also serves as a guide whereby a teacher can be directed in their practice. The Australian National Science Curriculum (2016) clarifies that science teachers aim to help students develop an interest, and by extension, motivation in science. In Australia, various science pedagogies and learning models have been introduced into the Australian National Science Curriculum (2016) to stimulate students' interest in and motivate students for learning science. One such example of this is using the 5E science teaching model by the Australian Academy of Science (2016) to develop the Science by Doing and Primary Connections programs for science students in year 7 to year 10.

### 3.6. The Role of Initial Teacher Education in Secondary Science

The primary goal of the science education curriculum is to provide learners with an opportunity to understand science in the public debate and decide about socio-scientific issues affecting their lives. Initial Teacher Education (ITE) programs offer a safe haven where prospective teachers' beliefs can grow and develop (Beeth & Adanan, 2006). Current research by Spencer (2018) shows that science teachers worldwide are in short supply due to varying reasons such as the migration of early career teachers to other academic disciplines or just a lack of interest in becoming science teachers in the first place. Spencer (2018) suggests that the high attrition rate of science teachers would mean that there needs to be frequent recruitment of new teachers and teacher educators to fill in the demand for teachers that may be brought about due to the migration of science teachers to other academic disciplines. This frequent recruitment is necessary to make science teaching look attractive and to get good quality prospective science teachers in the classrooms who can motivate students to learn science (Spencer, 2018).

### 3.6.1. How Initial Teacher Education Coursework can Influence Pre-Service Teachers' Teaching.

Initial teacher education courses have proved to be vital in influencing pre-service teachers' strategies during their professional experience placements (Palmer, 2007; Spencer, 2018). Beeth and Adanan (2006), in their study on the influences of university-based coursework on-field experience for pre-service teachers, report that the study's pre-service teacher participants reflected on many challenges/concerns that they experienced during their program. One of the most notable challenges/problems is the theory-practice divide that exists in teacher education. Beeth and Adanan (2006) continue to say that the findings from their research confirmed the notion of a gap in theory and practice, and teacher preparation programs need to do more to address and "…lessen the tension or bridge the gap that exists between theory and practice" (p.118). As a result of their study, Beeth and Adanan (2006) suggest that teacher educators should listen more keenly to pre-service teachers' concerns and find ways to address them as they occur. Moreover, another critical result from their study was that pre-service teachers should be informed that their beliefs about successful teaching are likely to change during their university program with a more specific focus on the professional experience placement.

When pre-service teachers get support from their ITE programs, they tend to be more efficacious in motivating and engaging students they teach during their placement period (Palmer 2008). Likewise, Spencer (2018) states that it is essential that ITE programs produce teachers who possess the skills needed to motivate students in science. Additionally, Fletcher and Luft (2011) complement the studies as mentioned earlier by suggesting that pre-service science teachers have an opportunity to consider how science is being taught during their time at the ITE program. Moreover, Fletcher and Luft (2011) suggest that as pre-service teachers progress through their teacher training, they can develop their abilities to create instruction that allows their students to follow lines of inquiry and be motivated to learn science.

### 3.7. Chapter Summary

The origin of teacher beliefs and the subsequent student motivation to learn science was highlighted by this review of the literature to reflect the theoretical lenses of the social cognitive theory (Bandura, 1977) and the four principles of motivation (Turner et al., 2011) through which data will be gathered and analysed throughout this study. In light of the literature reviewed, it is evident that although there has been research carried out on student motivation and teachers' beliefs, there has been very little literature published on how pre-service teachers' beliefs about student motivation in science are developing and are being enacted during their ITE programs.

In the next chapter of this study, the methodological design of this study will be discussed, including the methods and procedures undertaken for data gathering in the two phases of the research.

# Chapter 4

# Research Methodology

## Introduction

In the previous chapter, a review of the literature was conducted on teachers' beliefs about strategies for motivating students, focusing on how those beliefs originate and are enacted in the science classroom context. This research examines secondary science pre-service teachers' espoused theory and theory-in-use about strategies to motivate students to learn science at the lower secondary school level. The four research questions posed to address this aim were:

1) What are pre-service teachers' espoused beliefs about strategies for motivating students to learn science during their professional experience placement?
2) How do pre-service teachers enact their espoused beliefs for motivating students to learn science during their professional experience placement?
3) What factors influence pre-service teachers' theory of action about strategies to motivate students to learn science?
4) How do pre-service teachers' theory of action change as they progress through their professional experience placement?

The major theoretical framework described in chapter 3 of this study, serving as the basis for this investigation is the social cognitive theory and the four principles of motivation. Section 4.1 of this chapter presents a discussion of the rationale for choosing the methodology employed in this study. The research design is discussed in the following Section 4.2. In the next Section, 4.3, I describe the data gathering methods and procedures used. Section 4.3 begins with a description of the context and site of the research and continues with a description of the participants involved in the study and a description of the recruitment procedures used.

Furthermore, in Section 4.4 of this chapter, I discuss the procedures undertaken to ensure the validity of the instruments. I discuss the procedures undertaken to ensure the reliability of the research in Section 4.5. In Section 4.6, I present a discussion of the ethical considerations and methodological challenges of this study. The chapter ends with a summary of the chapter in Section 4.7.

### 4.1. Rationale for Choosing the Methodology

The methodological approach used in this study was qualitative in nature. Creswell (2012), in defining qualitative research, explained that the researcher attempts to investigate a phenomenon qualitatively. Creswell (2012) states that qualitative methods rely on the use of text and image data, and the researcher reflects on the role that he plays throughout the research. In this research, I enter the pre-service teachers' science classroom their social space during their professional experience placement in the sole capacity of being a researcher. Due to the qualitative nature of this study, I do not plan for the generalisation of the results.

Using the qualitative research methodology in this research has its advantages. One of the advantages is that it allows me to address the "what and "how" questions concerning my research. For instance, I can use a qualitative approach to describe how factors influenced pre-service teachers' theory of action about strategies for motivating students to learn science. This advantage of the qualitative methodology was suggested by Black (1994), who also stated that it "…can address causation and it involves observation and interpretation of events…it seeks to answer the "what" question" (p. 425).

Moreover, in this research, I aim to understand how pre-service teachers enact their espoused theories to motivate students to learn science during their placement. Black (1994) asserts that another advantage of this methodology was that it takes a "holistic perspective" of phenomena which "…preserves the complexities of human behaviour" (p. 425). Another advantage of using the qualitative methodology is that it can be used to study a small number of individuals in detail (Black, 1994), as in the case of this research. Furthermore, Black (1994) asserted that "The benefits of qualitative methods are greatest when the subject of study cannot be controlled and is poorly defined" (p. 425). This assertion by Black (1994) is important considering the nature of my study, seeing that the factors influencing pre-service teachers' beliefs and enactments of those beliefs are beyond anyone's control and that the concept, belief, is complex, which has made it difficult for researchers to define in their research.

The qualitative nature of the methodology used in this study suggested it was important to understand the context of phenomena being studied completely. In the Australian context, science teachers are responsible for helping students become motivated for learning science. One of the main drivers for this research is to see secondary science pre-service teachers help students become motivated to learn science. This desire was influenced by my knowledge of the following five Australian Professional Standards for Teachers:

1. Know your students and how they learn
2. Know the content and how to teach it
3. Plan for and implement effective teaching and learning
4. Create and maintain supportive and safe learning environments
5. Assess, provide feedback and report on student learning

The professional standards highlight crucial elements of social cognitive theory, such as creating and maintaining supportive and safe learning environments and the production of feedback and reporting on student learning. This, therefore, further justifies the social cognitive approach taken in this study since Shalin (1986) assert that in a socially constructed space, "…. the individual learns to do caring against the background of meaningful objects shared with others*"* (p. 12)

### 4.2. Research Design

A case study research design was employed in this study because it allowed for examining the identified phenomenon within a real-life context (Yin, 2009). This research examined how pre-service teachers' beliefs about strategies for motivating students to learn science are developing during their professional experience placement. Moreover, the case study design helped me present a detailed account of the phenomena being studied.

This case was defined by the multiple contexts of uncovering pre-service teacher beliefs about pedagogical strategies for motivating students to learn science and how those beliefs about strategies were enacted during their professional experience placement. Additionally, using a case study allowed me to understand factors that influenced pre-service teachers' beliefs about and enactments of strategies for motivating students to learn science at the lower secondary school level. The case study was contextually bound in that all participants were involved in secondary science education. Those participants included secondary science pre-service teachers, in-service science teachers, and students.

The descriptive nature of this research was vital to provide in-depth and rich data and reveal the espoused theories and theories-in-use of the secondary science pre-service teachers. The research questions of this study are descriptive in nature and seek to investigate the phenomenon of pre-service teachers' espoused theory about and theory-in-use about student motivation. Based on this, it is, therefore, fitting to use a case study design to explore the phenomena. Additionally, Punch and Oancea (2014) posit that the case study is "…the best way we have of getting the insider's perspective…the meanings people attach to things and events. This means they can be used to study the lived experience of people, including people's meanings and purpose" (p. 344).

A multisite case study was employed in this study. A multisite case study was used because this study was conducted in two main phases, with participants across different geographical sites: both physical and virtual sites, within Australia. Within the context of this research, the multisite case study was seen as the most appropriate type of case study for use in this current research. Punch and Oancea (2014) state that the multisite case study is useful when research is conducted on many sites or with many participants.

## 4.3. Methods and Procedures

In this Section, there is a description of the main sites within which the data were gathered. Additionally, there is an explanation of the two phases of this study and the processes involved in gathering data during each phase; this includes the participants involved, how the participants were recruited, access to the research sites and treatment of the gathered data.

### 4.3.1. Research Sites and Context

For this study, there were two main platforms within which the data were gathered. A virtual platform was employed for phase one of this study to gather data. This virtual platform comprised of the recruitment of secondary science pre-service teachers via social media to participate in a nationwide web-based survey (This is discussed in greater detail in Section 4.3.3.1). For this first phase of the study, a virtual platform was used to gather data from secondary science pre-service teachers throughout Australia. Gathering data throughout Australia was important to gain a snapshot of pre-service teachers' beliefs about strategies for motivating students to learn science, as well as the factors that influenced their choice of strategies during their placement period. Gaining an insight into the strategies used by pre-service teachers to motivate science students and the factors that influenced the use of those strategies helped me determine the methods used to gather data in phase two of this research.

For phase two of this study, the pre-service teachers were recruited from one university in regional New South Wales (NSW). This university is the largest education provider in that region of NSW. The university offers ten teaching degrees which includes a Bachelor of Teaching (Secondary), a Bachelor of Teaching (Secondary Science) Honours and a Master of Teaching (Secondary). The university's teacher education programs follow the Quality Teaching Framework, which, according to the Department of Education and Training (2003), comprises of the following three main pedagogy dimensions:

1. Intellectual Quality
2. Quality Learning Environment
3. Significance

The pre-service teachers recruited from the selected university conducted their professional experience placement at three separate secondary schools in regional NSW. As a result of the pre-service teachers' choice of placement, data for phase two of this study were gathered from 3 individual research sites. The three secondary science pre-service teachers, Paula, Elsa and Terry[1] , who participated, and their respective supervising teachers, Cassandra, Lorna and Rebecca, provided data that contributed to addressing all the research questions. The main reason why I proceeded with 3 case studies was because of the depth and breadth of data that he knew could be gathered from the three separate case studies on the phenomenon being investigated in this study.

Data for phase two of the study were gathered during November and December. This later data gathering period meant that some students were either preparing for or completed their yearly exams. In presenting the data gathered during this phase of the research, references are made to any similarities and differences among the 3 cases.

[1] Pseudonyms will be used for all participants and schools referenced throughout this research

#### *4.3.1.1. Case Context for Paula*

The first case focuses on Paula, a 37-year-old female who had previously spent five years enrolled in a doctoral program that she said comprised of a heavy science research and laboratory component. Paula stated that her love for teaching and passion for seeing students learn motivated her to pursue teaching as a career. Paula was in the first year of her Master of Teaching (Secondary Science) ITE program. She conducted her first professional experience placement while volunteering to participate in this research. Paula indicated that her love for research was what drove her to participate in this study.

For her professional experience placement, Paula chose to be placed at La Perle High School. La Perle High School is a suburban co-education public secondary school in regional NSW because it was relatively close to her home. The secondary school had an Index of Community Socio-Educational Advantage (ICSEA) rating of 1021, above the average value, 1000. There was a total enrolment of 861 pupils at the school at the time of the study. Out of the total enrolment figure, there were 5% Indigenous students and 6% of the students speaking a language other than English at home. The laboratories were in a separate school block, and students usually met Paula in the science laboratory for classes. There were chalkboards in the laboratories, as well as a digital projector. In the laboratories, the seating layout was configured so that students sat in groups of three or four facing the chalkboard. Cassandra was allocated as Paula's supervising teacher, and she had been a science teacher for over ten years at the placement school. Table 4.1 gives an overview of the three science lessons that I observed for Paula during her professional experience placement.

**Table 4.1.**

*Overview of the Three Science Lessons Observed for Paula*

| Topic | Time of Day | Duration of the Lesson (mins) | Year Level of Students |
|---|---|---|---|
| Human Impacts on Ecosystems | Late morning into early afternoon | 50 | Year 8 |
| Indigenous Practices | Late morning | 50 | Year 8 |
| Introduced Species | Morning | 50 | Year 9 |

#### *4.3.1.2. Case Context for Elsa*

The second case focuses on Elsa, a 33-year-old female who held a doctoral degree in science. She worked in a Laboratory as a demonstrator and scientist before deciding to pursue a Master of Teaching (Secondary Science) degree. At the time of conducting her professional experience placement, Elsa worked as a Laboratory Demonstrator for a Biology course at the university that she attended. This was Elsa's first professional experience placement. During her first interview, Elsa stated that her willingness to change to another profession motivated her to pursue teaching as a career. At the time of participating in this research, Elsa was enrolled in her first year of the Master of Teaching (Secondary Science) ITE program. In her first interview, Elsa stated that her love for science research drove her to participate in the study.

For her professional experience placement, Elsa chose to be placed at Riverdale High School, a rural co-education public secondary school in regional NSW. Riverdale High School had an ICSEA rating of 903 which was below the average value, 1000. There was a total enrolment of

1128 pupils at the school at the time of the study, with 19% Indigenous students and 6% speaking a language other than English at home. The school's science laboratory was located near the science department, which was in its administrative building. There was a chalkboard at the front of the classroom, and there was various apparatus, including microscopes and Petri dishes on the side benches. For her practical lessons, Elsa solicited the laboratory technician's assistance to prepare her equipment on the class's side benches or trays. Lorna was allocated as Elsa's supervising teacher. Lorna was employed as a science teacher at Riverdale High School for five years, her first teaching job. Table 4.2 gives an overview of the three science lessons that I observed for Elsa during her professional experience placement.

**Table 4.2.**

*Overview of the Three Science Lessons Observed for Elsa*

| **Topic** | **Time of Day** | **Duration of the lesson (mins)** | **Year level** |
|---|---|---|---|
| Building a kettle | Late morning/Early Afternoon | 60 | Year 8 |
| Making a stained wet mount | Early morning | 60 | Year 7 |
| Backyard blitz | Late Morning/Early Afternoon | 60 | Year 8 |

***4.3.1.3. Case Context for Terry***

The third case focuses on Terry, a 29-year-old male who worked as a full-time swimming coach while pursuing a Bachelor of Teaching degree. Terry was in his fifth year as a Bachelor of Teaching (Science) student**.** During his first interview, Terry stated that this was his second professional experience placement because he had previously completed a professional experience placement at a secondary school in regional NSW. In Terry's first interview, he explained that the primary motivation for pursuing a teaching degree was his love for watching students learn in a fun way.

Terry conducted his professional experience placement at Bell High School, a co-educational comprehensive secondary school in regional NSW**.** Bell High School is located in a suburban city in regional NSW**.** At the time of the study, Bell High School had a student population of 869 pupils and an ICSEA value of 968. Nine per cent of the student population was Indigenous students, and five per cent of the students spoke a language other than English at home. At Bell High School, the science laboratories were equipped with digital projectors, laptops, charts and various models. The laboratories were situated in a separate bock of the school, and the students were required to walk from their classrooms to the science lab for science lessons. Rebecca was allocated as Terry's supervising teacher. Rebecca indicated that she had been teaching science for five years at Bell High School**.** Table 4.3 gives an overview of the three science lessons that I observed for Terry during his professional experience placement.

**Table 4.3.**

*Overview of the Three Science Lessons Observed for Terry*

| **Topic** | **Time of Day** | **Duration of the lesson (mins)** | **Year level** |
|---|---|---|---|
| Global Environment | Early Morning | 50 | Year 10 |
| Waves and Communication/Light Theory | Mid Afternoon | 50 | Year 9 |
| Trivia Lesson | Late Morning | 50 | Year 8 |

### 4.3.2. Access to the Research Sites

For phase one of this study, because participants were recruited via the virtual platform, there was no need to enter a physical research site. The procedures involved in phase one data gathering are explained in Section 4.3.3.1 of this research.

For phase two of this study, I needed to gain access to the selected university in regional NSW. An email (see Appendix A) was sent to the science education subject Course Coordinator to request access to the secondary science methods class. After access was granted, the secondary science pre-service teachers were invited to volunteer to participate in phase two of the study. The secondary science pre-service teachers who volunteered to participate in this research were given an information sheet (see Appendix B), which contained information about the study, such as why it is being undertaken and its relevance/significance. The volunteers were reassured that their identities would be held in the strictest of confidence, and they were free to withdraw at any point of the research. The information statements also contained a consent form for the pre-service teachers to sign at their convenience

To gain entrance to the three sites where the pre-service teachers were placed to conduct their placement, I sent an email to the secondary school principal (see Appendix C). In the email, I introduced myself and my research. I included an information statement in the email and ethics approval documents from the University of Technology Sydney (UTS), ethics approval from the targeted university and the application approval document from the State Education Research Application Process (SERAP). The email also contained the proposed period, i.e., during the secondary science teacher's professional experience placement, when I was expected to visit the secondary school to conduct the research.

After permission was granted to conduct research at the selected secondary school, I met with the supervising teacher of the respective secondary science pre-service teacher who volunteered. I requested that the supervising teachers volunteer to participate in a 15 to 45-minute individual interview at the end of the secondary science pre-service teachers' professional experience placement. The supervising teachers agreed to participate in the research and were given a participant information statement and a consent form to sign (see Appendix D for supervising teacher participation information statement).

### 4.3.3. Data Gathering Procedures

This research was conducted in two phases. Phase one of the study involved gathering data from all pre-service teachers completing their Initial Teacher Education (ITE), Secondary Science programs at universities throughout Australia. Phase two of this study commenced after phase one was completed and involved gathering data from three (3) secondary science pre-service teachers conducting their professional experience placement at secondary schools in regional NSW and their supervising teachers. The following is a description of the procedures employed to gather data during the various phases of the data gathering process.

I. Survey (Phase 1)

According to Cohen et al. (2007), a survey is a descriptive method that gathers data at a particular point in time with the intention of describing the nature of existing conditions or identifying standards against which existing conditions can be compared or determining the relationships that exist between specific events. In deciding upon the use of a survey, three preliminary considerations, as proposed by Cohen et al. (2007), had to be taken:

i. The purpose of the inquiry. In the cause of this phase of the research, the purpose was to find out about preservice teachers' espoused theories about and theories-in-use for motivating students to learn science in the context of their professional experience placement. Moreover, I am trying to provide an overview of the factors influencing secondary science pre-service teachers' choice of strategies for motivating science students at the lower secondary school level.

ii. The population upon which the survey is focused. The survey was used to gather data from secondary pre-service teachers throughout Australia who were enrolled in an ITE program and either has completed or currently completing their professional experience placement.

iii. The resources available. Due to a limited budget, I resorted to using a survey. The type of survey used, Web-Based survey (described in Section 4.3.3.1), meant that I was able to plan and distribute the survey to the respondents with relative ease.

Overall, the focus of any survey is on what respondents are able and willing to verbalise or record in the context of the phenomenon being researched. The survey method: explained in greater detail in Section 4.3, involved gaining an overall view of the pre-service teachers' beliefs about strategies that they used to motivate students during their professional experience placement. Therefore, a survey is appropriate for this investigation.

II. Interview (Phase 2)

Education researchers have sought to describe what makes an interview. For instance, Dyer (1995) states that an interview should not be seen as an ordinary conversation because it should have a specific purpose. Cohen et al. (2007) state that interviews may have a different purpose. In this research, the purpose of the interview was to gather data about the phenomenon being studied. Moreover, Tuckman (1974) states that interviews provide access to what is inside a person's head and make it possible to measure what a person believes. Cohen et al. (2007) describe an interview as a flexible tool used to gather data from multisensory channels; that is, non-verbal, verbal spoken and heard. This meant that interviews are intersubjective in nature (Laing, 1967) and allows both the interviewee and interviewer to discuss their views of the world and express their beliefs about situations from their point of view Cohen et al. (2007). Therefore, it was fitting to use interviews to investigate pre-service teacher beliefs about strategies for motivating science students and to get their explanation of how their identified factors influenced their choice of strategies.

Although interviewing is advantageous for this study, I am aware that interviewing has its limitations. One methodological limitation of the interview method is that it relies on self-reporting. I negated this by using other data gathering methods such as observation and documentation to check for consistency in the data gathered.

III. Observations (Phase 2)

Observation involved gathering live data from naturally occurring social situations (Cohen et al., 2007). Cohen et al. (2007) further state that gathering data in situ is the greatest strength of the observation technique since it provides more authentic data than gathering data from second-hand sources. Moreover, Robson (2002) states that gathering data from observation is an important tool for triangulation since there is usually incongruence between what people say they do and what they actually do. As such, in light of the phenomenon being researched, that is, pre-service teachers' espoused theories and their theories-in-use concerning student motivation, it was vital to observe how pre-service teachers motivated students to learn science. Moreover, since observations are sensitive to contexts and have strong ecological validity, science lesson observations allowed me to discover things in the context of the pre-service teachers' professional experience placement that they may not mention during their interviews.

## IV. Documentation (Phase 2)

Documentation is important for giving visibility to any phenomenon being studied (Prior 2003). Cohen et al. (2007) state that documentation should be used in conjunction with other factors occurring simultaneously. As a result of this insight into documentation by Cohen et al. (2007), documentation was used in conjunction with the science lesson observation that I conducted with the pre-service teachers during their professional experience placement. Cohen et al. (2007) assert that documentation can take many forms such as field notes, memos or emails and technical documents. In this study, field notes were taken during the lesson observations, and the pre-service teachers' lesson plans for the science lessons observed were documented. Cohen et al. (2007) continued to posit documents that are written "live and *in situ*, may catch the dynamic situation at the time of writing" (p. 201).

Table 4.4 shows the research method (s) used in this research and the specific research question(s) each technique was used to address.

**Table 4.4**

*Table Showing the Methods, the Research Questions they Addressed and the Participants.*

| Method | Research Questions (RQ) | Target Participants |
|---|---|---|
| Survey (Qualitative and Quantitative Items) | RQ1, RQ2, RQ3, RQ4 | Pre-service teachers completing an undergraduate or postgraduate initial teacher education in secondary science at universities within Australia. |
| Interviews | RQ1, RQ2, RR3, RQ4, RQ5 | A total of 3 secondary science pre-service teachers from the postgraduate initial teacher education Secondary Science program from one University in regional NSW (each pre-service teacher was interviewed three times, and their supervising teachers were interviewed once) |
| Classroom Observations | RQ1, RQ2, RR3, RQ4, RQ5 | A total of 3 secondary science pre-service teachers from the postgraduate initial teacher education secondary science program from one University in NSW who conducted their professional experience placement at their selected secondary schools in regional NSW. (There was a total of 3 science lessons observed for each pre-service teacher) |
| Documentation | RQ1, RQ2, RQ3 | The same three secondary science pre-service teachers who were interviewed and whose science lessons were observed. |

#### *4.3.3.1. Phase One of The Data Collection: Web-Based Survey*

Phase one of this study involved gathering data from secondary science pre-service teachers enrolled in multiple universities throughout Australia. This was done via the use of an anonymous web-based survey created on Survey Monkey. The Australian wide anonymous web-based survey was necessary because it allowed me to have an idea of Australian secondary science pre-service teachers' beliefs about motivating students for learning science. Moreover, the web-based survey enabled me to gain insight into what strategies secondary pre-service science teachers used and how those strategies were used to motivate students for learning science. Finally, the web-based survey allowed me to get a snapshot of the factors that the pre-service teachers believed influenced their choice of strategies used during their science lessons. Creswell (2012) asserts that web-based surveys efficiently gather extensive data over a wide geographical area. By taking advantage of the use of the web and social media platforms, such as Twitter and Facebook, that individuals use today, this method was used to reach eligible participants all over Australia.

The web-based survey (see Appendix E) comprises four Sections with a mix of 5-point quantitative Likert scales and qualitative questions. The 5-point quantitative Likert scales within the web-based survey were quantitatively analysed using standard descriptive statistics and qualitatively analysed using a thematic approach. The 5-point Likert scales focused on gathering data from the secondary science pre-service teachers on their:

a. Beliefs about the extent to which they can motivate students for learning science.
b. The frequency with which they have used various teaching strategies to motivate science students during their professional experience placement.
c. Factors that may have influenced their choice of strategies to motivate science students to learn science.

The qualitative questions from the web-based survey sought to understand secondary science pre-service teachers' reasons for using specific chosen pedagogical strategies. Additionally, via the closed-ended questions in the web-based survey, participants were asked to give examples of pedagogical approaches they used to motivate students for learning science. They were asked to state any examples of pedagogies that were successful or non-successful at motivating students for learning science during their professional experience placement. The participants were also be asked to share advice with other pre-service teachers on strategies that can help motivate students to learn science at the lower secondary school level.

The survey construction the survey initially consisted of four (4) Sections as follows:

Section 1. Three items to obtain demographic information on the sample.

Section 2. Belief inventory: Five items arranged in a 4-point Likert scale and constructed to measure secondary science teachers' beliefs of how they can motivate science students. This Section was designed and adapted based on the format used by Riggs and Enochs (1990) in their Elementary Science Teaching Efficacy Belief Instrument. Riggs and Enochs (1990) created their instrument based on an indication that they realized that elementary teachers' efficacy beliefs were dependent on the specific teaching context. This realization led Riggs and Enochs (1990) to develop an instrument to specifically measure science teaching efficacy beliefs that they suggested should predict the classroom behaviours of science teachers. Moreover, Riggs and Enochs (1990) identified two dimensions of teacher self-efficacy that involved,

I. Teaching efficacy (outcome expectancy): Teachers believe that effective teaching can influence student learning.

II. Personal teaching efficacy (Self-efficacy): belief in their teaching abilities.

About the development of the Elementary Science Teaching Efficacy Belief Instrument scale, Riggs and Enoch's (1990) indicated that the items of the scale were assessed for both contents and construct validity by a panel of judges knowledgeable on the concept of self-efficacy. Additionally, Riggs and Enoch's (1990) indicated that factor analysis was done to attain a more reliable measure of the scale's construct validity.

The original self-efficacy scale developed by Riggs and Enochs (1990) comprised of the aforementioned factors (outcome expectancy) and self-efficacy with 25 items nestled under each factor of a 5-point Likert scale that ranged from strongly agree to strongly disagree with uncertain at the centre of the scale. Examples of the types of items that were found in the original self-efficacy scale developed by Riggs and Enochs (1990) were, (i) I am continually finding better ways to teach science (ii) Increased effort in science teaching produces little change in some students' science achievement.

Adaptations of Riggs and Enoch's (1990) self-efficacy scale made by me included items that were constructed based on the discussion of the literature review of the theoretical framework. Moreover, the items added were intended to better reflect the secondary science pre-service teacher context and theoretical lenses through which the study was undertaken, i.e., motivation.

Section 3: One closed-ended type item and three open-ended questions to measure secondary science teachers' strategies for motivating students at the lower secondary school level during their professional experience placement. This brings a total of four questions for Section 3 of the survey

Section 4. Factors that influence beliefs inventory. One closed-ended item and two open-ended questions were constructed to understand the factors influencing secondary science teachers' beliefs about student motivation during their professional experience placement. This brings a total of 3 questions for Section 4 of the survey.

Since I was the one who predominantly constructed the web-based survey, it was necessary to conduct a pilot test of the instrument. Therefore, in July 2019, the web-based survey was pilot tested with two pre-service teachers who were eligible to participate in this study. The pre-service teachers were emailed the link to the web-based survey were observed as they piloted the survey on their phones, tablets and computers. They were asked to report any difficulties they may have encountered while testing the web-based survey. All feedback received from the pilot testers were used to modify the survey question items and thus further enhance the validity and reliability of the types of responses received during the data-gathering phase of the study.

**4.3.3.1.1. Recruitment of the Participants for Phase One.** For this phase of the research, purposive sampling was used to select participants. Concerning using purposive sampling, Mills and Gay (2016) assert that "The benefit of this approach to sampling for a case study is the purposeful selection of cases that are information-rich…which the researcher can learn a great deal about the research problem." (p.422).

I purposively targeted all secondary science pre-service teachers who completed the initial teacher undergraduate or postgraduate secondary science program at universities in Australia. Targeting all secondary science pre-service teachers was done because he wanted to get a snapshot of their beliefs about pedagogical strategies used during their professional experience placement.

Participants were recruited via social media platforms such as Twitter, Instagram, Pinterest and Facebook. The link for the web-based survey and the quick response (QR) code was posted on those social media platforms where it was assumed that pre-service teachers would most frequently visit. Science teacher professional organisations, such as the Australian Science Teachers Association (ASTA) and the Australian Science Education Research Association (ASERA), were, with permission, tagged in the Twitter posts. Moreover, with the authorisation from the group administrators, pre-service teacher groups such as Preservice Teacher Chat (PST chat) were also tagged in the Twitter posts. Additionally, the survey link and QR code were posted on the walls of Facebook groups such as NSW/ACT Preservice Teachers and Australian Pre-service Teachers so that only Australian secondary science pre-service science teachers can access them.

Furthermore, I created a Facebook page and Instagram page for the study. On those social media pages, the survey link and the Quick Response (QR) code for the survey were posted along with a description of the research being undertaken. There were also stories and pictures about science and science motivation at the secondary school level on social media pages to attract as many participants as possible to partake in the survey. Throughout Australia, professional science organisations were also tagged in the survey link posts and followed. There was a total of 9 postings of the survey link and QR code on each of the aforementioned social media sites over ten weeks until data saturation was reached.

The demographic data from the web-based survey showed that there was a total of 75 respondents. The response rate for the web-based survey was calculated as being 93.33%. This calculated was because out of the 75 respondents, 70 completed the survey either partially or in full. The demographic data are crucial because it provides a lens through which data about pre-service teachers’ beliefs about and strategies for motivating science students can be contextualised and discussed throughout this chapter. The demographic data are presented in Table 4.5.

**Table 4.5.**

*Web-based Survey Demographic Data*

| | Items | Number of participants who responded |
|---|---|---|
| ITE Program level | Postgraduate ITE program | 33 |
| | Undergraduate ITE Program | 37 |
| Progress in Professional Experience placement | Finished some of their professional experience placement and has more to do | 56 |
| | Finished all their professional experience placement | 13 |

#### 4.3.3.2. Phase Two Data Collection

Phase two of this study involved gathering data from 3 secondary science pre-service teachers from one university in regional NSW who were enrolled in an ITE program. Data were gathered from 3 pre-service teachers because I felt confident that the number provided him with sufficient data to address the phenomenon being studied. Moreover, data were also gathered from the supervising teachers of the three secondary science pre-service teachers who conducted their professional experience placement at secondary schools in regional NSW. Phase two of this research was performed using a case study design. In this phase of the research, data were gathered using semi-structured interviews and unobtrusive lesson observation and documentation of the secondary science pre-service teachers' lesson plans and units of work. The data gathered from those case studies provided more meaningful insight into the factors influencing secondary science pre-service teachers' theory of action about strategies to motivate lower secondary school students for learning science.

***4.3.3.2.1. Interview.*** The semi-structured interview method was employed with the three individual secondary science pre-service teachers and their corresponding three supervising teachers. The main themes that semi-structured interviews explored included:

1. Espoused theories and sources of espoused theories which pre-service teachers may hold about strategies to motivate science students.
2. Strategies used by the secondary science pre-service teacher to motivate science students.
3. Factors influencing espoused theories and theories-in-use of science student motivation.
4. Change of the pre-service teachers' theory of action throughout their placement.

The aim of using the semi-structured interviews method was to gain a deep understanding of the factors influencing pre-service teachers espoused theory and theory-in-use during their professional experience placement. Using the semi-structured interview method, I allowed the pre-service teachers to describe some of their strategies for motivating students to learn science. Moreover, the semi-structured interviews allowed me to understand if, how and why the secondary science pre-service teachers believed their theory of action changed during their professional experience placement.

Semi-structured interviews were preferred to be used in this study instead of other types of interviews because I wanted the interview process to remain conversational and as situational as possible. Punch and Oancea (2014) state that an interview is a form of data collection in which participants are asked questions orally and are required to produce a response that can be recorded either verbatim or summarised. As a result of this conversational type interview, the secondary science pre-service teachers felt free to detail how they believed they motivated students to learn science. Punch and Oancea (2014) posit that "Interviews are one of the most powerful ways of understanding others" (p. 182). Moreover, using semi-structured interviews allowed me to recognise any gaps in the data being generated. This meant that I could close any gaps in the data, as suggested by Cohen et al. (2007), by asking pertinent questions so that those gaps could be clarified by the participants.

Three individual semi-structured interviews were conducted with three secondary science pre-service teachers who volunteered to partake in this study (see appendix F for Semi-structured interviews). The secondary science pre-service teacher semi-structured interview times ranged between 15-45 minutes. The interviews were conducted at a convenient time and place and via face-to-face, in a quiet room in the schools' library and via telephone.

The first semi-structured interview was conducted before the secondary science pre-service teachers did their professional experience placement. The purpose of that interview was to understand the secondary science pre-service teachers' espoused theories and beliefs concerning strategies they would use to motivate science students for learning science when they go out on their professional experience placement. The second semi-structured interview was conducted during the pre-service teachers' professional experience placement. The second interview's focus was to find out what strategies the pre-service teachers were using to motivate science students and how the pre-service teachers used those strategies to motivate students for learning science. The third semi-structured interview was conducted after the pre-service teachers completed their professional experience placement. The purpose of this interview was to find out whether the pre-service teachers' espoused theories and beliefs about student motivation in science given in the first changed upon completing their professional experience placement. Throughout those interviews, there was a line of inquiry about factors or experiences that may have influenced the pre-service teachers' beliefs about the choice of pedagogical strategies that motivated students to learn science.

In addition to interviewing the secondary science pre-service teachers at the three specified time points, their respective supervising teachers were also interviewed at the end of the professional experience placement (see Appendix G for supervising teacher interview). The supervising teacher semi-structured interviews were conducted at the supervising teachers' convenience via face to face and, in one case, via telephone for 15-45 minutes. The supervising teacher's semi-structured interviews were also held at a time that was convenient for them.

The purpose of supervising teachers' semi-structured interviews was to understand how they believed the individual pre-service teacher's espoused theory and theories-in-use was influenced by various factors during their professional experience placement. Moreover, the supervising teachers' interviews shed light on how the pre-service teachers' strategies were used to motivate students for learning science during the pre-service teachers' science lessons. Additionally, the supervising teachers gave reasons why they believed the strategies to motivate science students in those lessons were successful or unsuccessful at the time. The questions that were asked during the supervising teachers' semi-structured interviews can be seen in Appendix G. It must be noted that all interviews conducted in phase two of the research were recorded using an audio recorder and a backup audio recorder for safe keep.

***4.3.3.2.1.1. Recruitment of Participants for The Interviews.*** Convenience sampling was employed to recruit participants in phase two of this study. My choice of university and use of a convenience sampling procedure was because of the relative ease he could access the participants during the research period (Punch & Oancea. 2014). After the targeted university in regional NSW granted ethics clearance and permission to recruit the secondary science pre-service teachers', three secondary science pre-service teachers completing their postgraduate ITE program were recruited during their science methods class. The secondary science pre-service teachers who volunteered to participate in this research were given an information sheet (see Appendix D), which contained information about the study, such as why it was being undertaken and its relevance/significance. The volunteers were reassured that their identities would be held in the strictest confidence, and they were free to withdraw at any point of the research.

The secondary science pre-service teachers' supervising teachers were also purposively recruited. The supervising teachers were purposively selected to ascertain their opinions and observations of the pre-service teachers' theory-in-use during their placement period. Data were gathered from 3 secondary science pre-service teachers and their corresponding supervising teachers in this phase of the study. Concerning the small number of participants in this phase of the case study, Mason (2010) states that as research goes on, gathering more data may not lead to more information on a subject/topic being studied. Additionally, Punch and Oancea. (2014) justify small numbers in a study by asserting that having more participants can pose a challenge since it would mean that more time would be needed and effort when analysing data. Moreover, by choosing three pre-service teachers and their respective supervising teachers for this research, I believed that he would have sufficient data to address the phenomenon being researched.

**4.3.3.2.2. Lesson Observation.** In this research, unobtrusive lesson observations were used to gather data about what strategies were used and how the pre-service teachers used them to motivate students for learning science. Cohen et al. (2011) posit that observation involves looking at and noting events, people, and behaviours systematically. They continue to purport that observation is a suitable means of gathering data by looking *"Directly at what is taking place in situ…" (*p. 456) instead of relying on second-hand information about the occurrence of an event. A non-participant/ unobtrusive observer approach was employed during the lesson observation process. The reason for this was so that I would not become part of the observation process or disturb the pre-service teachers' science lesson in any way (Punch & Oancea, 2014). Ciesielska et al. (2018) suggest that the non-participant observer is an outsider who positions him/herself in the background to watch and take notes on the phenomenon under study. During my observations, I positioned myself in an inconspicuous spot to the back of the classroom while observing and taking field notes throughout the science lesson observations.

The observed science lessons were chosen by and convenient for the secondary science pre-service teacher and supervising teacher. A total number of six science lessons were observed: with each science lesson being 60 minutes in duration. This number of lesson observations provided data that helped give more insight into the phenomenon being studied throughout this research (Yin, 2009).

During the science lesson observations, field notes were taken to record how the pre-service teachers used pedagogical strategies for motivating students to learn science concepts. Flick (2000) states that fieldnotes are used in research to allow researchers to record their observations. Those fieldnotes were structured to contain the following:

1. The year level that was taught

2. The subject
3. The time of day when the subject was taught
4. The number of students in the classroom
5. The atmosphere (physical and/ emotional)
6. Pedagogical strategies used by the pre-service teacher
7. How the strategies were used to motivate students during the science lesson

The science lesson observations were conducted to investigate some of the themes that emerged from the data from the web-based survey conducted in phase one of this study.

**4.3.3.2.2.1. Recruitment of the Participants for Lesson Observations**. Lesson observations were conducted with the same three secondary science pre-service teachers who volunteered to be interviewed because they also gave consent for their science lessons to be observed during their professional experience placement. The reason for observing the selected pre-service teachers' science lessons was done to gain triangulation of the data gathered from the interviews. Before the lesson observation formally began, I requested permission to visit the secondary school from the principal, where the secondary science pre-service teachers were placed. This visit aimed to establish a rapport with the supervising teachers and to develop familiarisation of the secondary science classroom. This familiarisation included meeting the secondary science pre-service teachers in the classroom environment to feel comfortable and relaxed later during the science lesson observations.

Moreover, students who were going to be in the science classes where the researcher conducted the observations were given an information sheet for their parents/guardians (see Appendix H). The information sheet given to the students detailed the purpose of the science lesson observations and to reassure student's parents/guardians that:

i. Students would not be observed or recorded,
ii. The class schedule would not be disrupted in any way during the duration of the lesson observation,
iii. Only the strategies to motivate science students that are was used by the pre-service teacher would be recorded in a notebook in my fieldnotes.

**4.3.3.2.3. Documentation**. Documentation was used in phase two of the research. Documentation of the pre-service teachers' science lesson plans was conducted to obtain data from the participants required to understand the following.

a) The strategies that individual pre-service teachers planned to use to motivate science students throughout their science lessons,
b) How individual pre-service teachers planned to use those strategies to motivate science students.

Punch and Oancea. (2014) assert that when used in conjunction with observation and interview, document analysis can aid with the triangulation of data gathered and provide meaningfully and a significant amount of data. The primary documents captured during the data gathering process were the pre-service teachers' science lesson plans and artefacts that emerged during the science lessons. Goldsmith and Seago (2011) indicate that artefacts can be samples of learners' work done in the classroom setting. As such, with the permission of the pre-service teacher, evidence of hands-on activities conducted during the science lessons was recorded in a manner that would not be easily identifiable to any student/ school or the pre-service teacher. Moreover, any artefacts recorded during the pre-service teachers' science lessons were coded using pseudonyms and archived for ease of reference. Moreover, the pre-service teachers' science lesson plans for the lessons that I observed were also used as part of the documentation process.

### 4.3.4. Analysis Procedures

The data gathered from the web-based survey in Phase One were mainly analysed using thematic analysis (Miles & Huberman, 2014) with a combination of qualitative descriptions and a small amount of descriptive quantitative statistics. The data analysis was guided by all the major themes and elements of the theoretical framework discussed in Chapter 2, which included the four principles of motivation in the social cognitive context. I ensured that I selected the data from the web-based survey and simplified that data for every participant; see Appendix L to analyse it easier.

The data gathered from phase two were also analysed using thematic analysis (Miles & Huberman, 2014) and were coded based on the four principles of motivation (see appendix M), using qualitative descriptions for the three participants. The data sources provided descriptions and comments that aided in analysing the data about what happened during the science lessons that were observed for each pre-service teacher. Findings specific to each observed science lesson were presented and analysed according to how they addressed the research questions using the key concepts of the theoretical framework as preliminary codes. As part of the data analysis, I resorted to comparing data across the three separate pre-service teacher cases to draw conclusions about the trends noticed throughout the data.

During the period within which the science lesson observations occurred, field notes were taken by me as well as the collection of pre-service teachers' lesson plans. Those lesson plans and field notes were assessed and answered the research questions. The field notes recorded for each pre-service teachers' lesson observation were analysed based on the emerging themes. The audiotape recordings from the semi-structured interviews were transcribed; see Appendix N and used during data analysis to provide in-depth accounts of how the pre-service teachers developed their theory of action.

## 4.4. Establishment of Validity of the Instruments

Regarding establishing the validity of the web-based survey and semi-structured interviews, I considered the internal and external validity as well as the face, content and construct validity of the instrument. Punch and Oancea. (2014) indicate that the internal validity of a research instrument could be threatened by many factors such as subject attrition, selection and maturation. To ensure the internal validity of the web-based survey, I posted the survey link on many social media platforms to reach potential participants who were eligible to participate in this research. Additionally, with the assistance of science subject coordinators, the web-based survey link was posted to the blackboard sites of universities. By posting the link to the web-based survey online, I gave every potential participant who visited those social media platforms and students who access their university's blackboard platform an equal and probable chance of participating in phase one of the study. For the semi-structured interviews, I addressed the internal validity by ensuring that he requested as many volunteers as possible to partake in this phase of the research during the recruitment period.

Three professional science educators assessed the face and content validity of the web-based survey. Three lecturers from the University of Technology Sydney (UTS) provided feedback based on pre-established guidelines for the study. The guidelines included definitions of key terms used in the study, such as theory of action, defined by Argryis and Schon (1974), motivation, defined by Santrock (2018). Moreover, the assessors were given the specific research questions to be answered by the web-based survey and the documents and /or theoretical base used in the construction of the various Sections and question items of the web-based survey. The recommended alterations provided by the assessors about the web-based survey were made before I pilot tested the instrument.

The web-based survey and semi-structured interviews' construct validity was assessed during the pilot-testing phase. The web-based survey and semi-structured interviews were piloted using a sample of pre-service teachers; selected by purposive sampling who were not eligible to participate in this study. The pre-service teachers were instructed to indicate whether they had any issue with any item on the survey and to be free to make suggestions to me.

Establishing construct and content validity for the lesson observations was done by ensuring that the constructs to be observed were based on the main themes that emerged from the web-based survey and the secondary science pre-service teachers' semi-structured interviews. In general, I ensured that I took into account and addressed all the complexities of the study, for example, the research questions. Since this research is qualitative, it is contextually bound, and as such, I included as much detail about the context as possible so that other researchers can understand the research context.

## 4.5. Establishing Reliability of the Study

In qualitative research, the term reliability is often replaced with terms such as credibility, neutrality, confirmability, dependability, consistency, applicability, trustworthiness and transferability, particularly the notion of dependability" (Cohen et al., 2011, p. 148). Bearing in mind that the reliability of a qualitative study provides a measure to which the study can be replicated in a similar context, using the same methods to achieve similar results (Cohen et al., 2011), I addressed the reliability of the study as follows.

### 4.5.1. Dependability

Establishing dependability for this research involved ensuring the stability of the gathered findings over time. (Bitsch, 2005). The results, particularly in phase two of this research, were evaluated by the participants who examined the data to ensure an agreement with the data that I gathered. Moreover, to establish the research's dependability, I created an audit trail to do crosschecking by other future researchers (Guba & Lincoln, 1982). This audit trail consisted of the raw data gathered, including all interview transcripts, science lesson observation field notes and artefacts gathered. Furthermore, I coded and recoded the data gathered within a month to compare the two sets of codes for any agreement (Chilisa & Preece, 2005).

### 4.5.2. Credibility

My research's credibility was established via Prolonged engagement, Persistent observation, and Triangulation, as suggested by Guba and Lincoln (1989). Credibility involves the correctness of the interpretations made from the raw data (Guba & Lincoln, 1989). In the context of this research, there was continued engagement with an adequate number of pre-service teachers, who were observed teaching periodically during their professional experience placement. Concerning triangulation, data were gathered using various methods, namely, web-based survey, observation, interviews, documents analysis/artefacts science. Data were gathered from different sources so that triangulation could occur and obtain corroborating evidence on factors influencing pre-service teachers' theory of action about strategies for motivating students to learn science at the lower secondary school level.

### 4.5.3. Transferability

In this research, I ensured that clear, unambiguous descriptions of all processes undertaken were provided. Participants of this study were purposively chosen, using a set criterion previously described in the participants' Section's recruitment. Transferability can be defined as the extent to which results from this study can be generalised to other contexts with other respondents (Bitsch, 2005). Bitsch (2005) asserts that transferability can be done by providing detailed descriptions and purposive sampling.

## 4.6. Ethical Considerations and Methodological Challenges

Ethics approval was needed before conducting this research to ensure that my research was ethically sound. Ethics approval was granted by the University of Technology, Sydney (see Appendix I), as well as by the state authority for schools, NSW State Education Research Application Process (see Appendix J), and the participating university's (see Appendix K) ethics committee. For phase two of this research, consent forms were provided to the three pre-service teachers and their corresponding supervising teachers. Those consent forms sought approval for the participants' participation in semi-structured interviews and science lesson observations (for the pre-service teachers).

The study was clearly explained to all participants via an information statement for participants in both phases of the research. Additionally, for participants from Phase Two of the research, the study was explained to them verbatim. Clearly explaining the investigation to the participants helped them understand the risks associated with their participation and how I planned on mitigating all risks identified. Moreover, the participants were told that they were free to withdraw from the study at any time. The steps mentioned earlier to ensure ethics mitigating procedures were undertaken because Gay et al. (2009) indicated that the most critical ethical issues in research as no harm should come to the participants in any way.

Furthermore, Cohen et al. (2011) posit that “Ethical issues may stem from the kinds of problems investigated by social scientists and the methods they use to obtain valid and reliable data” (p.76). For this study, the main ethical issues that needed to be addressed were the following.

### 4.6.1. Anonymity and Confidentiality

One of the most sensitive issues in research is the aspect of participants’ responses being kept anonymous and confidential. Participants were not required to place their names on the web-based survey. The participants were required to click on the web-based survey link, which opened up to the survey page, which the secondary science pre-service teachers can access to complete the survey without placing any self-identifying information. This process kept the participant’s identities hidden for phase one of this research (Mills & Gay, 2016).

Phase two of this research, however, posed a methodological challenge since the participants were required to sign and return the consent form and give contact information so that they could be contacted throughout the remainder of the study. This challenge was handled by reassuring the participants that their names would be de-identified and not used in any publications coming out of this research. Additionally, pseudonyms were used for each of the three pre-service teacher participants in this phase of the study. Pseudonyms were also used for the secondary schools where the secondary science pre-service teachers conducted their professional experience placement. Moreover, information about the participants or schools was not shared with anyone, and all data were securely stored, and password protected on UTS OneDrive, Cloudstor and Stash platforms.

## 4.7. Conclusion of Chapter Four

In this chapter, I focused on discussing the methodology and the design and the data gathering procedures in phases one and two employed for this study. Moreover, the procedures for establishing the validity of the study and the chapter concludes with a discussion of the ethical methodological challenges of the study.

I demonstrated that the qualitative methodology chosen for this research supported the inclusion of theoretical views about pre-service teachers' beliefs about science student motivation that helped research in the context of the social space of pre-service teachers' professional experience placement. The case study research design employed to gather data involved using interviews, surveys, observations, and documentation methods was also explained and justified.

In this chapter, I also described the two main phases of the research; Phase one and phase two, how data were gathered within each phase and the participants involved in the data gathering process. Additionally, I discussed how the data gathered were analysed via qualitative means, such as using a thematic approach to examine the significant emerging themes from both phases of this study.

Moreover, I discussed the steps taken to ensure the validity of the study and the instruments used to gather data. Explaining how the instruments used in the study is a vital process as it sets the foundation for which the finding of this study can be accepted within the science education context.

The methodological challenges concerning the reliability of the study were also addressed, and the primary ethical considerations of the research were discussed. The main ethical issues that needed attention were informed consent, ensuring that no harm befell the participants, whether physical or psychological and ensuring the participants' confidentiality and anonymity.

Considering those ethical dimensions of the study was critical because, in both phases, the pre-service teachers gave detailed accounts of their personal beliefs about strategies for motivating students to learn science. Additionally, in phase two of the study, the participants allowed me to witness their theory-in-use during their professional experience placement.

In the following chapters, I present a qualitative analysis of the data gathered based on the emerging themes for phases one and two of this study in chapters six and seven. I end the study with chapter eight, including the conclusion and recommendations from my research.

# Chapter 5

# Phase One Findings and Discussion

## Introduction

In Chapter 4, this study's methodology and the research design was discussed. I discussed why the qualitative approach was best suited for this research. The research site and context were also described, along with the procedures for gathering data from the participants in both phases of this study. Finally, the methodological challenges, including the research's validity, reliability, and ethical considerations, were addressed.

The web-based survey was conducted to gain a snapshot of the pre-service teachers' beliefs about strategies for motivating students to learn science. In this chapter, the results from the web-based survey relevant to the research questions of this study are presented and analysed. In Section 5.1, in analysing data gathered from Phase One, there is an exploration of the pre-service teachers' espoused beliefs about strategies for motivating students for learning science in the context of their professional experience placements. These espoused beliefs will be analysed based on Turner et al.'s (2011) four principles of motivation: developing students' competency, fostering belongingness in the classroom, giving students autonomy, and making learning meaningful. In Section 5.2, I analyse and discuss the pre-service teachers' theories-in-use; that is, how they enacted their espoused beliefs about strategies for motivating students to learn science. The chapter ends with Section 5.3, where the factors influencing the pre-service teachers' theory of action are analysed from the perspective of the triadic reciprocality model (Bandura, 1977) of social cognitive theory.

## 5.1 The Pre-Service Teachers' Espoused Theories

In this study, it was deemed necessary first to ascertain the pre-service teacher beliefs, as researchers assert that beliefs held by teachers have a profound effect on their pedagogical practices (Jones & Carter, 2007; Ogunkola & Samuel, 2011; Pajares, 1992; Riggs & Enochs, 1990). There has been general agreement amongst science education researchers that beliefs are mental constructs representing an individuals' perception of truth and reality, subsequently guiding their behaviour (Cruz et al., 2019; Pajares, 1992). Cansiz and Cansiz (2020) investigated profiling pre-service science teachers' early experiences, beliefs about teaching, and teaching practices. They suggest that this investigation into beliefs is vital as pre-service teacher beliefs have been the most ignored issues of curriculum implementation and should be explored to support pre-service teachers in enacting their beliefs.

The secondary science pre-service teachers espoused strong positive beliefs about motivating students to learn science. An examination of the belief scale (see Question 1, from the web-based survey in Appendix E) shows that 43 out of the 63 pre-service teachers who responded to the question item were in agreement with the statement: "I believe that I know how science students can be motivated to learn science." Furthermore, 44 respondents indicated that they knew how to facilitate students' learning of science concepts to motivate them.

The high number of pre-service teachers who believed that they could motivate students for learning science was a surprising finding because many researchers have linked pre-service teachers' beliefs about their ability to motivate students for learning to their self-efficacy beliefs (Aydin & Boz, 2010; Bandura, 1994). Guskey and Passaro (1994) pointed out that teachers' self-efficacy beliefs refer to "The belief or conviction that they can influence how well students learn, even those who may be difficult or unmotivated" (p. 628). Those beliefs are important because they play a significant role in how pre-service teachers process new information during their initial teacher education program. As such, pre-service teachers' self-efficacy can determine how they engage with students and the pedagogical strategies they choose to motivate students to learn science. Ma and Cavanagh (2018) have alluded to the importance of pre-service teachers' self-efficacy beliefs in acting as an indicator of how well prepared a teacher is to achieving teaching goals. They contextualised this importance in terms of how teachers plan for instruction and interact with students, their ability to evaluate their teaching practices, and the type of learning environment they create in the classroom.

Researchers have viewed teacher self-efficacy as a motivational construct that influences student achievement in the classroom. Pendergast et al. (2011) explain this high self-efficacy by stating that pre-service teachers are more likely to overestimate their level of self-efficacy before having prolonged practical experience. Furthermore, researchers such as Jean-Baptiste et al. (2019) claim that pre-service teachers' tendency to develop unrealistic and idyllic beliefs about how they can motivate students to learn science leads to an overestimation of their self-efficacy beliefs. Moreover, science education researchers agree that science teachers' self-efficacy beliefs directly affect the types of strategies, such as group work or discussions, they use to motivate students to learn science (Berger et al., 2018; OECD, 2009).

The findings of Phase One of this study support the results of previous science education studies (e.g., Cruz et al., 2019), which highlight that secondary science pre-service teachers generally possess a high self-efficacy in teaching science. Researchers have found that this high self-efficacy maintained by secondary science teachers is critical. It provides the impetus for them to spend above-average time planning for their science lessons and finding innovative ways for motivating students to learn science (Cruz et al., 2019; Deemer, 2004). Moreover, those highly efficacious teachers tend to support student autonomy in the science classroom and build good relationships with low achieving students to motivate them to learn science (Ross & Bruce 2007). The research literature points to the formation of teachers' beliefs regarding strategies for motivating students considering the four main principles of motivation (Deci & Ryan, 2002; Deci et al., 1991; Turner et al., 2011). Data regarding the use of various strategies for motivating students to learn science nestled within the four principles of motivation are examined in the following section.

### 5.1.1 Developing Students' Academic Competency

An essential part of developing students' academic competency is giving students personalised feedback on academic tasks. In this phase of the study, I found that the central espoused beliefs about developing students' academic competency to motivate them for learning science were via feedback and by demonstrating to students that mistakes/errors during learning are informational; that is, students can learn from their mistakes after those mistakes are pointed out by their teachers and after reflecting on how they can improve on their performance.

#### *5.1.1.1 Providing Feedback to Students*

The findings reveal that of the 63 respondents who responded to the belief scale in the survey, 52 agreed that students could be motivated to learn science when given personalised feedback on classroom assessments. Moreover, some of the respondents suggested that when they were students themselves, this affected their emotions and encouraged them, which further motivated them to learn. Respondent # 61 claimed, *"The students feel good when I give them feedback on their work."* Respondent # 44 stated, "*I think maybe the students wanted to know their level before they continued their work, so when I gave them feedback, they continued working harder"* and "*When I give students feedback, they feel happy, and that motivates them to work."*

Respondent # 38 stated that giving *"Good feedback on tasks helps ensure that the students understand the topic that was done, and that is a good way to motivate them."* These quotes highlight the respondents' awareness of the importance of giving students feedback and the emotional reactions that are evoked from students when they receive it. According to Sarsar (2017), such emotional reactions are critical to motivating the students to learn.

The findings of this phase of the study suggest that the participants perceive feedback in a way that aligns with what research shows about feedback effectiveness. The findings also support those of Erickson (2021), Hattie and Timperley (2007), Mahvelati (2021), Orsmond et al. (2005), who have alluded to the importance of feedback and an instructional strategy in motivating students to learn. Furthermore, the findings concerning feedback in this phase show similarities to the results of many studies around the world that examined how giving students feedback can motivate students for learning. In their study, Leibold and Schwarz (2015) also suggested that feedback is essential and supports learning if given in a prompt manner that is clear, detailed, individualised and frequent. Koenka and Anderman (2019) conducted a study in the USA and concluded that giving middle school students personalised feedback is vital and can alter student motivation to learn if used appropriately.

Additionally, despite the findings of the web-based survey showing that when the pre-service teachers give students feedback, they can develop competency in science and thus be motivated to learn, researchers such as Beghetto (2006) and Middleton and Midgley (2002) disagree with this finding. Beghetto (2006) stated that giving students feedback is not enough for teachers to build and sustain students' competency. In Middleton and Midgley's (2002) study conducted in the USA, they suggested that for students to develop a strong ~~sense of~~ competency, they need to experience academic press, which is a situation where teachers pressure students to challenge themselves to understand concepts being taught by not allowing them to engage in tasks that they perceive as easy.

The results concerning feedback emerging from this phase of the research are notably different from other studies examining feedback in education. For instance, in the USA, Sims-Knight and Upchurch (2001) found that giving students feedback may not necessarily be a good practice. They indicated that although feedback can be very effective in promoting learning, giving too much feedback on their work can be deleterious and prevent them from focusing on learning effectively. Furthermore, Sims-Knight and Upchurch (2001) suggested that it is essential for teachers to help students learn how to assess and reflect on their state of learning to become independent life-long learners.

The similarities and differences of the findings concerning using feedback by teachers to develop students' competency to motivate them to learn science explored across the literature highlight the importance of the current findings.

One way in which feedback supported developing students' competency was by allowing them to see that making mistakes while learning is informational. For instance, Respondent # 61 claimed that after giving the students feedback on their academic tasks, they are usually "*motivated to learn from their errors and continue succeeding in particular KLAs.*" This quotation demonstrates an awareness that feedback is essential to help students learn from their mistakes or errors when doing academic tasks/assignments because it held them develop an understanding of their work better, which motivates them to learn. Teachers must let students know that making mistakes/errors is informational to be motivated to learn even further. Turner et al. (2011) indicated that teachers should let students know that mistakes are informational because they allow both students and teachers to know which concepts students are having difficulty with, and by doing this, students will develop increased competency to learn. Additionally, Leibold and Schwarz (2015) found that when teachers correct students' errors, they help students improve their performance in learning tasks and assignments. Other studies have also reported that when students receive error correction, their motivational reactions are activated, leading to improved competency and achievement (Wang et al., 2019).

### 5.1.2 Fostering Belongingness in the Classroom

Fostering belongingness in the classroom is vital for motivating students for learning (Turner et al., 2011). In the Phase One findings, it was revealed that the respondents showed that they believed that a crucial part of fostering belongingness in the classroom was by engaging students in collaborative/cooperative group work. One of the leading contemporary beliefs espoused by the pre-service teachers was that they believed that when students feel belonging in the classroom, they are more motivated to learn science.

#### ***5.1.2.1. Engaging Students in Collaborative/Cooperative Group Work***

A significant finding from this phase of the study was that 36 out of the 52 pre-service teachers believed that when students are engaged in collaborative group work activities, they can help each other become motivated to learn science. For instance, Respondent # 29 stated she believed that by *"placing students in groups to work, students could help each other grasp the concepts being taught."* Another fascinating insight came from Respondent # 10, who believed that "*Group work allows students to relate the content to each other. In this way, they are talking about the content rather than having the teacher direct them in a particular way."* Based on the responses, the pre-service teachers demonstrated an understanding of the positive social dynamics that occur when students are placed in groups. These findings also show that they were aware that placing students in learning groups is essential to help them because of their affinity for relating concepts to each other by coaching one another.

The findings concerning engaging students in collaborative group work reveal two main points. First of all, the findings indicate that the pre-service teachers generally believed that when students engage in collaborative group work, social interactions amongst students and their teachers are created in the classroom that gives the students a chance to relate to each other and bond. Watts et al. (2020) similarly found that when students participate in group work activities, they gain a feeling of belonging and are more motivated to learn. Moreover, Brouwer et al. (2019), commenting on how group work can aid in creating a bond in the classroom, indicated that students who participate in collaborative group work activities get to know each other very quickly, and this may give them a feeling of belonging within the classroom environment. Van Duijn et al. (2003) also found that when students frequently meet in group settings, they get to know each other better and develop belongingness. In addition to developing belongingness, when students participate in group work, they can be more motivated to achieve and learn the intended learning outcomes of a lesson (Gillies, 2003).

Secondly, to the category that collaborative group work helps students develop belongingness, the findings also revealed that the pre-service teachers agreed that group work helps create a social space where students help each other relate content to each other and become motivated to learn science. Respondent # 29 stated that "*They [students in their groups] were also able to relate the concepts to each other's lives*." Prawat and Floden (1994) asserted that when students engage in social negotiation within the classroom or group setting, their knowledge and social meanings about a particular concept become more refined and evolve. Brouwer et al. (2019)

also noted this but added that students are more likely to interact with their peers and teachers when they feel as though they belong to a group in a safe learning environment. Additionally, Brouwer et al. (2019) stated that the learning environment plays a crucial role in helping the students feel socially integrated, essential for developing belongingness in the classroom and being motivated to learn.

Despite a large majority of the pre-service teachers espousing various ways to foster collaborative group work to motivate students for learning science, others suggested that collaborative group work may not be beneficial to the students. For example, Respondent # 29 stated that his collaborative group work strategy was *"not effective because they [students] prefer working with their friends (in groups)*." Furthermore, Respondent # 35 stated:

> *I realised that sometimes when I place students in groups, they are not as productive as they would be when they work with a peer of their choosing because the students would be disrupting each other, going off-topic most times and not focused on the activity at hand.*

As espoused by the survey respondents, this lack of productivity by students when engaged in group work activity sheds a different light on the aspect of using this strategy to motivate students in the science class. Respondent # 44 stated, *"When students are in groups, they get distracted and do not work efficiently most times."* Based on these opinions from Respondents # 29, # 35, and # 44, I assert that the pre-service teachers are aware that it may not be rewarding to place students in groups to work because of the distractions that students may experience as they interact with each other. Those distractions that may occur during group work may lead to students not paying attention and may deter the teacher from using group work as a strategy, as implied by some respondents. For example, Respondent # 44 said*, "I allow students to work on their individual* *tasks; they are less distracted [than when they work with groups] and make better use of their time in the classroom."* This hesitation by the respondents in using the more contemporary socially based group work strategies because of the distraction that students may experience in groups may cause the teachers to use other strategies, for instance, individual tasks, which may not necessarily motivate students to learn science.

Although contrary to the environmental factor of the social cognitive theory (Bandura 1977), which highlights the importance of social interactions in the learning environment, this finding from this current research is supported by research conducted by Adar (1969) and Hofstein and Kempa (1985), who suggest that it should not be assumed that all students will be drawn to a cooperative group work way of learning. Adar (1969) indicated that cooperative group work strategies only effectively motivate students who are "social" in nature and that students who are not "social" may find it difficult to partake in cooperative group work activities and thus not be motivated to learn in those instances. Other researchers have uncovered the power of peers on each other's motivations and engagement levels for learning in the classroom context and indicated that peers are an essential part of the social context of youth (Ryan et al., 2019; Ryan & Ladd, 2012; Wentzel & Ramani, 2016).

The results of Phase One of this study concerning the fostering of belongingness showed that the pre-service teachers espoused collaborative/cooperative group work as an effective way of fostering belongingness in the science classroom to motivate students for learning science. This shows the importance of pre-service teachers understanding how to create a sense of inclusion in the classroom to motivate students to learn. Although supported by ample literature, this finding is also contrary to the research done by Adar (1969) and Hofstein and Kempa (1985). It highlights contention in the literature around the strategy of engaging students in collaborative/cooperative group work, as embedded within the principle of motivation, fostering belongingness amongst students.

### 5.1.3 Giving Students Autonomy

A vital part of giving students autonomy in the classroom is by allowing them choice in what they want to learn. The findings of the web-based survey in this study show that one respondent out of 63 (Respondent # 14) believed that when students are given autonomy in the classroom, they will become more motivated to learn science. Respondent # 14 espoused that she believed it is essential to "*Give the students autonomy over their learning*" and "*allow them space to create their lessons and have fun with their learning.*" When students are given the opportunity to create their lessons, for instance, the concepts they want to learn surrounding the topic at the time, as expressed by Respondent # 14, they may feel a sense of ownership in that lesson and be more motivated to learn science.

This finding that only one pre-service teacher espoused giving students autonomy is surprising because researchers are in general agreement that providing students autonomy supports them to develop greater motivation for learning (Chirkov et al., 2003; Furtak & Kunter, 2012; Patall et al., 2018); Reeve, 2009; Reeve & Jang, 2006). Paulo Freire (2018) also suggested that students should be allowed autonomy (freedom) in all aspects of the learning process, including the planning (creating) of lessons.

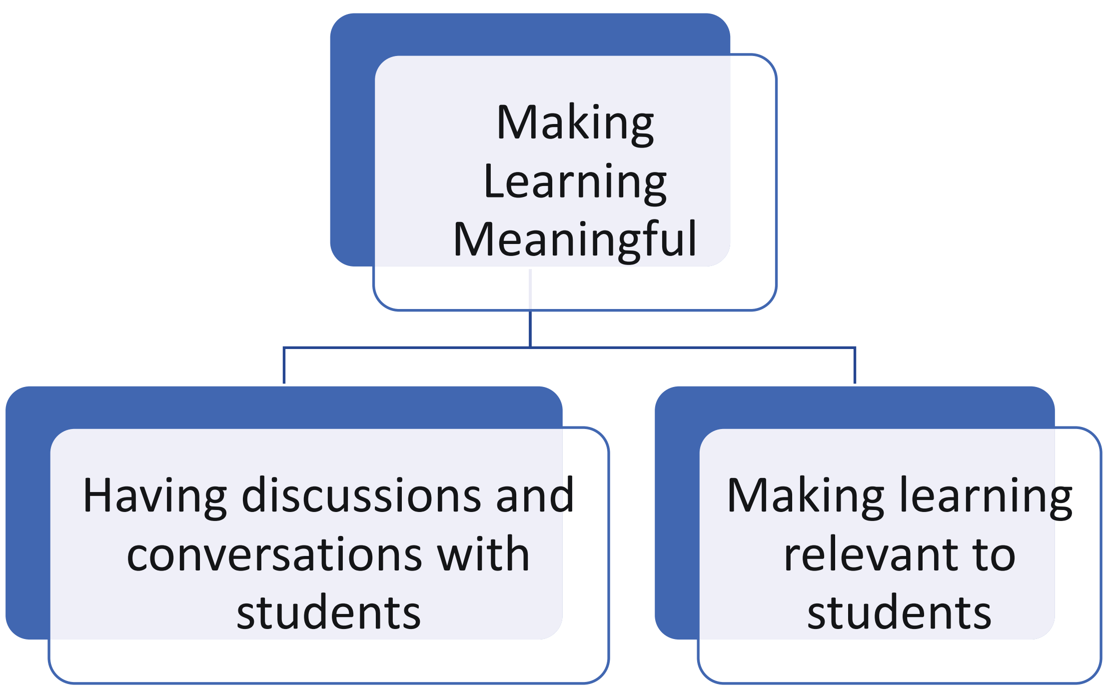
Although this finding of the lack of pre-service teachers giving students autonomy during science lessons is concerning, Reeve (2009) states that it is not uncommon for novice teachers to resort to control strategies, such as the lecture method, when teaching students. Brouwers and Tomic (2000) found that teachers with lower self-efficacy tend to use more controlling techniques in the classroom and have the tendency to refer students to other school personnel. I have asserted that pre-service teachers' controlling or authoritative stance in the science classroom is a result of their generally low self-efficacy for teaching science and lack of help with their classroom management at the time of their professional experience placements. Ma and Cavanagh (2018) concluded that pre-service teachers' self-efficacy regarding classroom management needs to be investigated further.

### 5.1.4 Making Learning Meaningful to Students

The findings of the web-based survey showed that the respondents made learning meaningful (See Figure 5.1) to students by engaging them in discussions and having conversations about the concepts being taught, getting to know them, and relating the concepts to their everyday lives.

***Figure 5.1***

***Making Learning Meaningful to Students***



#### *5.1.4.1 Having Discussions and Conversations with Students About the Concepts Being Taught*

In Phase One of this study, 8 out of 65 respondents agreed that by having discussions and conversations about the concepts being taught, students would find learning meaningful and motivated to learn science. For instance, Respondent # 61 stated, *"I use a lot of discussions, and I realised that students are more motivated to partake in the discussion when they can connect [relate] to it [the concept being taught]."* Respondent # 16 stated, "*Discuss concepts in more than one way."* From the written quotes by Respondent # 61 and Respondent # 16, it can be seen that they realised that students were more likely to participate in discussions on topics they could relate to and that discussions could be held in more than one format. I assert that this realisation concerning the use of discussion as a strategy is essential because within the environmental factors aspect of social cognitive theory, when learners partake in discussions, they negotiate their ideas with other learners, which may motivate them to learn. Moreover, having discussions and conversations with students to motivate them to learn science is viewed by researchers (Brophy, 2013, Palmer, 2007) as essential for building shared understandings of concepts with their peers.

The category having discussions and conversations with students about the concepts being taught supports Rovai's (2007) research in the USA, which found that learners are more likely to engage in discussions that they believe reflect events in their lives because they can easily integrate their own experiences into the discussions and if the topic being discussed holds particular meaning. Additionally, Respondent # 61 echoed Knowles's (1989) idea that when students learn what they believe they can relate to, they are less likely to resist participating in discussions.

The other main idea concerning discussions suggested by Respondent # 16 was that discussions should be held in several formats. Although the respondent did not clarify that statement, researchers agree that various formats (e.g., whole class, small group, and online) of discussions can help learning become meaningful to students and help them become motivated to learn (Hew & Cheung, 2012; Lee & Martin, 2017; Qui et al., 2014; Schellens & Valcke, 2006).

#### *5.1.4.2 Making Learning Relevant to Students*

The findings for this category were captured by two Likert scale items on the web-based survey. The findings from the web-based survey in this study reveal that the respondents believed that (1) they could make learning relevant to students, and (2) that by relating science content to everyday life and knowing their students, they could motivate them for learning science. Forty-three out of a total of 52 respondents who responded to that Likert scale indicated that they related science content to the students' everyday lives. In this phase, it must be noted that there was an equal number of respondents selecting the two items; *I related science concepts to everyday life, and I believe that I know how students can be motivated to learn science.* Based on the similar number of respondents choosing the items mentioned earlier in the belief Likert scale, it is reasonable to deduce that if the respondents take the time to get to know students, they would probably be able to relate better to the concepts being taught to their lives.

One way of making learning relevant to students, which one pre-service teacher espoused, is by considering the students' culture. Respondent # 45 suggested that there is a *"difference in cultural backgrounds"* of the students and that students should be given *"examples that are culturally relevant"* to motivate them for learning science. Respondent # 45's consideration of the students' culture and giving culturally relevant examples during teaching is vital because when students understand science concepts in their culture, they may be more inclined to be motivated to learn. When teachers relate science to students' culture, they may understand concepts quickly and see connections to those concepts in their day-to-day lives because culture represents people's way of life (Goodrum, 2019). Additionally, the Australian Professional Standards for Teachers reinforce Respondent # 45's, highlighting the importance of getting to know students' cultures to make learning relevant to students. For example, Standard 1 of the Australian Professional Standards document indicates graduate teachers should "Demonstrate broad knowledge and understanding of the impact of culture, cultural identity and linguistic background on the education of students from Aboriginal and Torres Strait Islander backgrounds" (Australian Institute for Teaching and School Leadership, 2011, p. 9).

Decades ago, Saville-Troike (1978) recommended that teachers adapt their techniques for motivating students based on their cultural differences. More recently, Williams et al. (2018) examined the issue of using relevance and meaningfulness from a different angle and found that students from a middle school could be motivated for learning through science-based teaching that was culturally relevant and made connections between the students' communities and daily interests.

The other way respondents suggested that they made learning relevant to the students was by relating science concepts to real-life (43 out of 52 respondents). Respondent # 8 indicated that she makes learning meaningful to the students by showing students *"the relevance of the ideas and concepts taught to their everyday lives and how to apply these to solve real-world problems."* Respondent # 20 stated he believed that "*using real-life examples brings a sense of realisation to the concepts, which help students' understanding"* and leads to meaningful learning. Using real-life examples and relating science concepts to students' everyday lives to help them solve real-life problems is one of the notable responsibilities of learners in both the personal and environmental factors of social cognitive theory. This may be understood more clearly by observational and vicarious learning concepts. In those concepts, learners are to observe a real-life model similar to them performing tasks in real life. The learner would then be motivated to learn the particular task if he or she can relate to the model performing the task. Similarly, when pre-service teachers present real-life examples of concepts that the students can relate to, they may learn via vicarious experiences. Therefore, the comments espoused by the respondents point to the connection they made with making instruction pertinent to students' lives and the real world in general so that students can relate to the learning materials with which they engage.

Priniski et al. (2018) presented similar arguments that the increased use of examples of concepts that are familiar and of personal relevance to students contributes to their ability to develop better situational interests and thus become motivated to learn in the classroom. Their research indicates that relevance and meaningfulness are not mutually exclusive.

This phase of the study also revealed that most of the respondents indicated that they knew how to motivate students. From the web-based survey, 43 respondents agreed with the Likert scale statement; *I believe that I know how students can be motivated to learn science*. This Likert scale statement was inspired by Standard 1 in the Australian Professional Standards for Teachers document: teachers should "Know Students and How They Learn." (NSW Education Standards Authority, 2018, p. 4). The high number of respondents selecting this item demonstrates their awareness of the importance of motivating students to learn science.

The findings for the category making learning relevant to students from the web-based survey also point to specific written responses that the many pre-service teachers made about the importance of getting to know students to motivate them to learn science. For instance, Respondent # 20 stated that it was important that teachers *"know their students and what works for them."* Moreover, Respondent # 45 said he believed that pre-service teachers should "*know your students, where they are at so that you could plan for them."* As indicated in the Australian Professional Standards for Teachers, several different focus areas point to the importance of getting to know students. For example, it is crucial to know the student's physical, social and intellectual development so that teachers can plan the learning experiences for them. In the context of social cognitive theory, knowing students may be an essential aspect of the environmental factors influencing learning, such as their interests and their prior knowledge in the social context of the school and classroom Bandura (1977). Moreover, social interaction may also allow a teacher to understand students and plan science lessons that will help motivate students to learn science.

This result of the web-based survey complements the findings on teacher preparation by Cochran et al. (1993), who stressed that teachers' knowledge about students should comprise the students' abilities, ages, developmental levels, attitudes, motivations, and their prior knowledge of concepts to be taught. Furthermore, the web-based survey results are supported by the findings of Qian and Lehman (2017) that by knowing students and the knowledge they bring into the classroom, teachers could quickly identify misconceptions that they may have toward a particular concept and be better able to choose strategies to clarify them. In addition to the survey, the respondents espoused that knowing students would help create a feeling of belonging that would lead to them planning lessons that cater to the students, which can motivate the students to learn science.

The pre-service teachers also espoused that knowing the students' diverse learning needs were equally important. Respondent #57 also suggested that if pre-service teachers "*know students",* they will be better able *to "prepare the lesson so all of them can be excited about learning science."* Knowing students' diverse needs links back to the Australian Professional Standards for Teachers, including teachers' consideration of students' social, religious and cultural backgrounds. Ng et al. (2010) also found that pre-service teachers who are willing to support the diverse needs of their students are more effective at motivating students to learn.

### 5.1.5 Summary of the Web-Based Survey Participants' Espoused Theories

The beliefs espoused by the pre-service teachers during Phase One of this study should be regarded as espoused theories about strategies for motivating students to learn science. This conceptualisation of pre-service teachers' espoused beliefs stemmed from studies conducted on teachers' beliefs about student motivation support the current findings of this research. The following section analyses the pre-service teachers' theories-in-use and how they enacted their various espoused strategies to motivate students to learn science.

## 5.2 The Pre-service Teachers' Theories-in-Use for Motivating Students to Learn Science

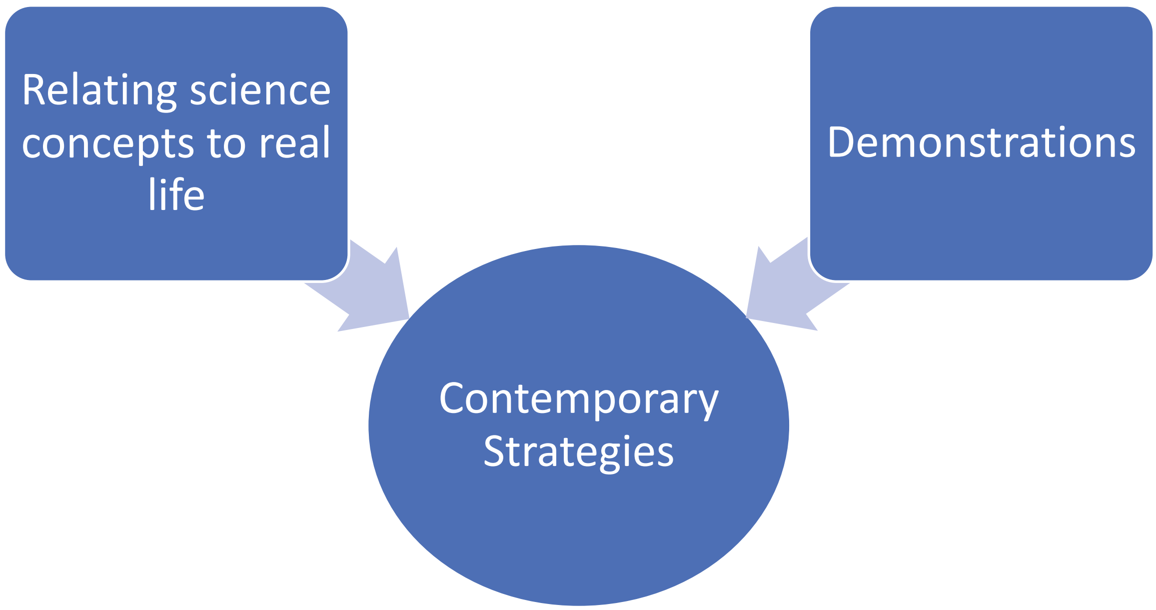
The findings of the web-based survey reveal that the pre-service teachers used several contemporary strategies to motivate students for learning science during their professional experience placements. In Section 2.2, I described contemporary strategies as those aligned with current views of teaching that are generally student centred in nature.

### 5.2.1 Contemporary Strategies Enacted to Motivate Science Students

Contemporary strategies for motivating students included widely accepted modern teaching strategies used by teachers in the classroom to motivate students for learning. The findings of the web-based survey revealed that pre-service teachers used a variety of contemporary strategies to motivate science students for learning science during their professional experience placement. The two main contemporary strategies (seen in Figure 5. 2) that the pre-service teachers used for motivating science students to learn science were, using demonstrations and Relating science concepts to the students' real-life

**Figure 5.2**

***Contemporary Strategies used for Motivating Students to Learn Science***




**5.2.1.1 Using Demonstrations as a Strategy to Motivate Students for Learning Science**

The contemporary strategy that 48 out of 52 respondents often used during their pre-service teachers' placement was demonstration. For example, Respondent # 29 indicated that while teaching the topic *"Circulatory and respiratory systems"* with her Grade 8 class, she used a model of the circulatory system "*to demonstrate how the circulatory system works and charts were used to give them [students] a visual representation of the various systems."* This use of demonstration highlights Respondent # 29's awareness that it can help students understand concepts by visually representing how science concepts relate to each other. The use of demonstration in conjunction with other visual tools is vital for ensuring that students are motivated to learn science in this manner. Within the social cognitive theory context, demonstrations play a vital part in vicarious learning.

It is postulated that if students see the teacher perform a demonstration successfully in one context, they can be motivated to learn how to do that demonstration. O'Brien (1991) asserted that demonstrations could guide students to construct accurate conceptualisations in science. Additionally, for Sherburn (2012), demonstration is a crucial component of science classes because it allows science teachers to illustrate concepts and explain scientific theories in engaging and enjoyable ways, and hence their students are more likely to be motivated to learn science.

The findings of this study also show that the pre-service teachers indicated that students pay attention and attempt to replicate what they observe during demonstration. An example came from Respondent # 36, who indicated that *"The demonstration was done…* [for the topic separating mixtures] *and then the students were able to carry out a similar task successfully."* Moreover, Respondent # 51 stated, *"I have found that when I demonstrate what needs to be done, and the students get a chance to replicate the activity, they are better encouraged to keep working at that activity."* These examples point to the pre-service teachers' understanding of a specific part of the social cognitive framework that makes up this study, namely, observational learning. Therefore, this finding is supported by the underpinnings of social cognitive theory (Bandura 1974) and is part of a persons' personal factors influencing their behaviour. I assert that students can become even more motivated to learn science after gaining feedback from their teachers on tasks they successfully demonstrate. This assertion is because the final process/aspect of observational learning is motivation, in which teachers tend to give students feedback on their successful replication of demonstrated tasks to encourage them to continue the behaviour.

The findings that demonstration is used to motivate students for learning science also support the views of Chiappetta et al. (2002), Roadruck (1993), and Shakhashiri (1985), who claim that when students pay attention to the demonstration process, this can help stimulate their thought processes. Research by Brophy (2013) also supports the findings and shows that the degree to which a particular motivational disposition develops in a person is influenced by the modelling and socialisation (communication of expectations, direct instruction, corrective feedback, reward, and punishment) provided by significant models in the person's environment.

#### *5.2.1.2 Relating Science Concepts to Real Life*

The second strategy to motivate students for learning science that 43 out of 52 pre-service teachers reported was that during their professional experience placements, they related science concepts to the students' lives. This theory-in-use was found to be similar to the pre-service teachers' espoused theory (discussed in Section 5.1) concerning making science learning meaningful to the students. Many respondents to the survey provided illustrations of how relating science content to real-life examples contributed to motivating students to learn science during their placements. One example came from Respondent # 60, who stated that for a morning science lesson with Grade 10 students on the topic "*Questioning and Predicting,"* she had the *"students pretend to be scientists and do internet searches about current science issues that needed to be investigated. The students role-played and questioned as well as made predictions as to what they think would happen during their science investigations."* The respondent went on to add that *"the role play made the students feel as if they were real scientists. They even had lab coats while they searched the internet on their Ipads for current issues in science."* The respondents realised that relating students' learning to real-life during their science lessons is essential because it allows them to plan authentic learning experiences that can help students become motivated for learning science.

Similar results from studies by Brophy (2013) have equated relating science concepts to students' real lives to authentic learning where the onus is on the teacher to ensure that students are engaged in simulations and actual-life applications of the concepts. Brophy (2013) suggests that while such role-play/simulation exercises do not take much time to conduct or prepare for, they can stimulate students' interest because of the relatability of the content to their personal lives. Anand and Ross (1987) also found that in role-playing, students participate in referencing people or things with whom they identify and thus become more motivated to learn. Therefore, in the context of this study, getting to relate science content to the students' lives, although stemming from various platforms, has the vital role of motivating students to learn science because students can form a connection to the teachers.

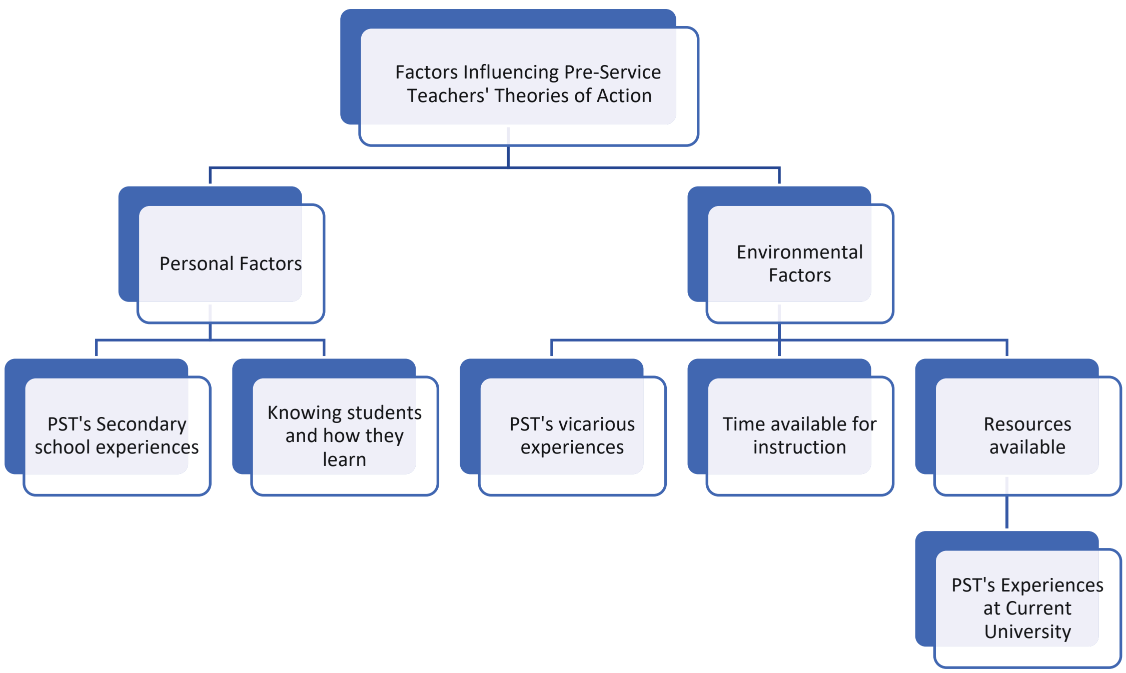
### 5.3. Factors Influencing Pre-Service Teachers' Theory of Action About Their Choice of Strategies for Motivating Students to Learn Science

The data gathered for Phase One of this research indicates that several factors influenced the pre-service teachers' strategies to motivate students to learn science. Based on the triadic reciprocality model proposed by Bandura (1995) (described in Section 2.1), the primary factors emerging were categorised as personal and environmental factors. As described by Bandura (1995), personal factors are those that surround the individuals, for example, beliefs, intentions, emotions and encompass their cognitive events (observational learning), biological events (temperament) and affective events (personal and vicarious learning experiences). Bandura described environmental factors as those that manifest in the form of stimuli, opportunities, and norms. Environmental factors are, in essence, beyond the learner's control and include physical and sensory events and social events (such as friends and family).

In this section, the data analysis concerning the factors influencing the pre-service teachers' theory of action was done after I presented what the pre-service teachers espoused as factors. Those espoused factors were matched to the respondents' theories-in-use to offer a possible explanation of how these factors (seen in Figure 5. 3), which were found in the web-based survey, influenced their strategies to motivate students for learning science.

**Figure 5.3**

***Factors Influencing PSTs' Theory of Action (Phase One)***




### 5.3.1. Personal Factors

The main personal factors influencing the pre-service teachers' theory of action about their choice of strategies for motivating students to learn science, revealed from the findings of the web-based survey, were:

1. Pre-service teachers' secondary school experiences
2. Know students and how they learn

***5.3.1.1 Pre-service Teachers' Secondary School Experiences***

Most respondents believed that their experiences as secondary school students influenced their motivation to learn science during their professional experience placement. This finding was not surprising because this category was selected by 50 out of 52 respondents who responded to this item. Throughout the survey data, there were many examples of how the respondents' secondary school experiences helped them develop their ideas for motivating students to learn science. One example came from Respondent # 3, who stated, "*Thinking about what I had done in high school and what I enjoyed or did not enjoy and employing these [motivational] strategies.*" Furthermore, Respondent # 3 provided an example of how his espoused belief about his school experiences influenced the strategies used to motivate students for learning science. The respondent stated students were motivated to learn science when he related science to real-life concepts and *"Have students conduct open-ended investigations."*

Like Respondent # 3, Respondent # 44 espoused that her strategies for motivating students were based on what motivated her to learn during her time at secondary school. Respondent # 44 said, "*I usually like teaching the way I was taught when I was younger. I believe that if it [the pedagogical method] motivated me, it would also motivate the students whom I teach.*" The respondent indicated that her theory-in-use comprised using "*PowerPoint presentations and charts*" as strategies to motivate students to learn science. Moreover, Respondent # 44 asserted that *"I give students praise when they do well on assignments.*" Respondent # 44's responses were comparable to Respondent # 3, which also represented the similar types of responses from other respondents who chose this category; "*My own experiences as a secondary school student*" from the web-based survey.

The quotes by Respondent # 3 and Respondent # 44 show that the pre-service teachers made two assumptions regarding their personal learning experiences from secondary school and their teaching experiences. The first assumption is that they believe that if they were motivated to learn science after the use of a particular strategy in high school, then believed that their students would be motivated to learn science in the same manner, thus they intend to teach using the strategy that motivated them to learn science. The second assumption made by the pre-service teachers, especially Respondent # 3, is that if a strategy did not motivate them to learn science during high school, then it would not motivate their students to learn science. As a result of this second assumption, the respondents described mainly strategies they liked or those that motivated them to learn science, not considering that students may be motivated to learn science through other strategies. The two assumptions demonstrate that the pre-service teachers were aware of how important their learning at high school influenced their theory beliefs about and enactment of strategies to motivate students for learning science. Those assumptions by respondents are understandable and fall in line with the personal factors which underpin the social cognitive theory.

Within the personal factors, it is expected that if a learner is/was directly involved in a pleasant experience, then the chance of the learner wanting to be part of that experience later is higher. In the context of the findings, it can be said that the respondents' secondary school science learning experiences that they enjoyed motivated them to learn science, and as such, they believed and used similar strategies to what they enjoyed for motivating students to learn science during their placement.

The findings are supported by other similar research. For instance, Hopper (2000) made similar claims to the findings of this study when he studied whether PE teachers teach in the way they were taught. Hopper (2000) concluded that teachers generally teach in the way they were taught at the secondary school level. Another study by Cox (2014) supports this current finding. Cox (2014) concluded that teachers are more prone to teaching how they are taught, especially if they experienced a positive experience when learning. Moreover, the findings of this phase of the study support research conducted by Niyukuri et al. (2020), who commented on the role that pre-service teachers' secondary school experiences impact their pedagogical practice. Niyukuri et al. (2020) suggested that pre-service teachers' experiences, whether bad or good, experienced when they were secondary school students could influence how they teach.

#### *5.3.1.2. Know Students and How They Learn*

Nine out of fifty-two respondents indicated that getting to know students was an essential factor determining the types of strategies used to motivate them. The low number of students choosing this category was surprising considering the high number of pre-service teachers (43 out of 52 respondents) who espoused that they believed that by getting to know students, students would be motivated to learn science in section 5.1.4.2. The low numbers choosing this factor is surprising as it is important because getting to know students is one of the Professional Knowledge in the Australian Professional Standards for Teachers document.

The respondents who selected this factor provided examples of how they generally believed they should get to know the students to motivate them for learning science. Some examples of those espoused quotes include:

- *Know your students and know which strategies can be used to ensure that they all understand the lessons being taught*
- *Planning lessons to include all types of learners*

- *Relate it to their lives. Show them you are interested in and appreciate the contributions they make*

Additionally, Respondent #45 stated that knowing students' cultures and backgrounds was necessary for instruction. The respondent was quoted as saying, *"Because of the difference in cultural backgrounds, I had to use differentiated instruction and give examples that are culturally relevant to the students."* Concerning students' knowing students' backgrounds, Respondent # 57 was quoted as saying, "*The type of students I have, determines the type of strategy I will use to teach a particular lesson. I try to cater to all my students."*

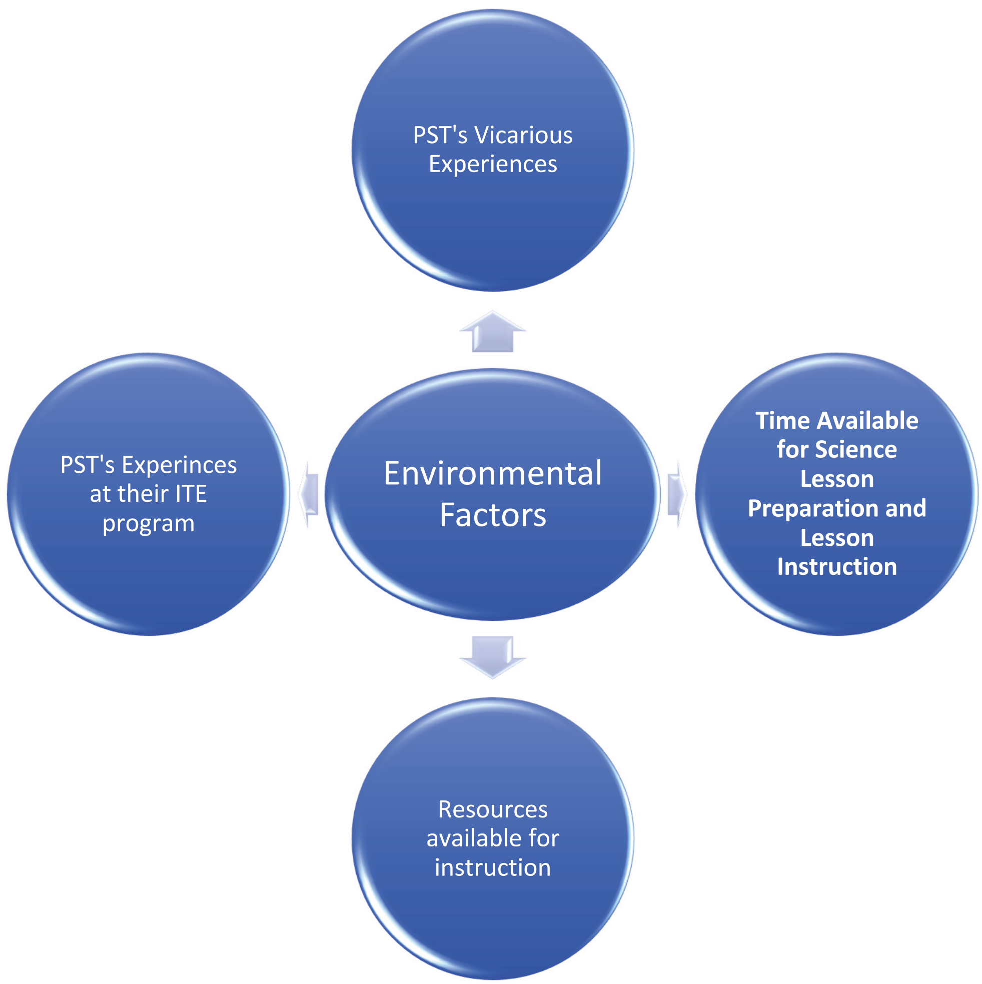
Despite the low numbers of pre-service teachers choosing this factor, the findings further highlight the pre-service teachers' belief that knowing students and how they learn can impact the students' motivation to learn science. The findings for the category know students and how they learn to show that teachers know that it is essential to plan for the various types of students considering their backgrounds as expected from the Australian Professional Standards for Teachers. The 43 pre-service teachers who chose this category show that they understand the importance of getting to know students and how they learn to plan differentiated experiences that will motivate them to learn science. This understanding of knowing students and how they learn is vital since learning mainly occurs in the social setting within the social cognitive theory context. When the pre-service teacher gets to know students, they may be able to create social environments where they can relate science content to the students' cultural backgrounds or other backgrounds (e.g., socio-economic background).

**5.3.2. Environmental Factors**

The main environmental factors (seen in figure 5.4) that influenced the pre-service teachers' theory of action about strategies to motivate students for learning science during their professional experience placement were vicarious learning experiences, time available for science lesson preparation and lesson instruction, resources present for instruction and pre-service teacher experiences at their current university. The environmental factors presented in this Section stem from the findings of the web-based survey.

**Figure 5.4**

***Environmental Factors Influencing Pre-service Teachers' Theory of Action***



***5.3.2.1. Pre-service Teachers' Vicarious Learning Experiences***

The pre-service teachers' vicarious learning experiences category comprised three other constructs. The respondents chose those constructs as influencers on their theory of action about strategies to motivate students for learning science. This category was coded as vicarious learning experiences because respondents generally indicated that their beliefs about strategies to motivate students originated from observing other teachers instructing science and getting advice from other teachers. Table 5.1 presents subcategories that made up the overarching category of the vicarious learning experiences and the numbers of respondents in each subcategory.

**Table 5.1**

*Subcategories Making up the Vicarious Learning Experiences Category*

| **Item** | **Number of Respondents (N=52)** |
|---|---|
| Observing other teachers teach | 47 |
| Advice from my supervising teacher | 42 |
| Other teachers where I conducted my placement | 41 |

Respondents' beliefs about how vicarious learning experiences influenced their choice of pedagogical strategies were first captured by the web-based survey's first Likert scale. The findings from this Likert scale illustrate the extent to which respondents believed that vicarious learning experiences influenced their choice of strategies for motivating students. A total of 49 out of 63 respondents who selected that item agreed that they could motivate students to learn science after applying feedback about their teaching from their supervising teacher and other teachers. An example of vicarious learning came from Respondent #31. This respondent was quoted as stating:

> *The feedback from supervising teachers is always effective as constructive feedback is usually given. It is also essential to get suggestions from other teachers on how to teach a particular topic, especially if they have years of experience and have taught that lesson several times.*

The last question of the survey was, "*Can you share some advice for other pre-service teachers preparing to teach lower secondary science? What can pre-service teachers do to motivate science students to learn at the lower secondary level?"* Respondent #31 went on to offer advice to other pre-service teachers by letting them know that it is essential to "*Get feedback from other teachers on how you can improve a topic being taught."* The idea of using the feedback from highly experienced supervising teachers is not a surprising finding because the respondent may trust the supervising teacher's mentoring skills and the pedagogical content knowledge that the teachers possess. In that way, by relying on feedback from teachers, the respondents can, in turn, better their ability to choose strategies that can motivate students for learning science. Considering that pre-service teachers do not learn in isolation but are part of a broader social network of teachers, it is understandable that they would see feedback from their supervising teachers on the strategies they use to motivate students to learn science as essential to help them form their theory of action.

The findings, therefore, show the importance and value pre-service teachers place on the feedback from their supervisor to help them shape their theory of action about strategies for motivating students to learn science. When pre-service teachers gain feedback on their theory-in-use by their supervising teachers, they will be most inclined to engage in reflective practice to better understand the strategies they can use to motivate students to learn science. This assertion is supported by Campoy (2000), who suggested that teachers' reflective practice can be supported when pre-service teachers gain feedback on their practice and are provided with opportunities to practice teaching by teacher educators. Hardy and Kirkwood (1994) also made an important point when they asserted that pre-service teachers must also be allowed to reflect on and articulate their learning experiences and processes. Additionally, the importance of feedback to assist reflective practice was also supported by Abell et al. (1998), who made it clear that novice science teachers be granted time to think critically about science teaching and learning.

Respondents who chose vicarious learning experiences as a factor also described instances where other teachers influenced their theory of action about strategies that they used to motivate students to learn science during their placement. For example, Respondent #53 espoused that:

> *Observing other science teachers and asking how they delivered a particular lesson is always good. You can use the best method to make your students want to participate and learn more about science concepts.*

The respondent went on to suggest that other pre-service teachers who may try to motivate students for learning science during their placement should "*Consult with other teachers to get ideas on which strategies work best for certain topics.*" The high percentage of responses for the vicarious learning category was not surprising because researchers have shown that ideas and beliefs about motivating students are likely to form due to the social interactions amongst teachers in the teaching profession (Skamp & Mueller, 2001). These findings, therefore, support the importance given to vicarious learning experiences by various researchers such as Skamp (1995), Wideen et al. (1998), Skamp and Mueller (2001), and Howitt (2006) in shaping human beliefs and their behaviour. Furthermore, Howitt (2006) and Skamp and Mueller (2001) linked pre-service teachers' observations of science lessons in the placement school to their beliefs about using specific teaching strategies to motivate students to learn science.

Considering the arguments that have been raised so far, the finding for this category has pointed to the social interaction of pre-service teachers with other teachers within their placement school and outside as well as their supervising teachers as possibly being one of the most substantial contributors to their beliefs of how to enact strategies for motivating science students. Moreover, the findings for this vicarious learning experiences category (Observing other teachers teach, advice from my supervising teacher and other teachers where I conducted my placement) indicate that observing and communicating with other teachers about the best strategies for motivating students to learn science helped validate her perceptions of strategies she used to motivate students. This validation considered the possibility that those in-service teachers may have had more teaching experience than her and would probably know how to motivate better students whom they teach.

Based on the environmental factors which form part of the triadic reciprocality model of the social cognitive framework within which this study is situated, pre-service teachers learning about strategies for motivating students to learn science from other teachers is expected to occur. The environmental factors affecting how persons learn align with the pre-service teachers' vicarious learning experiences category, which shows how persons in the social world influenced the pre-service teachers' theory of action about strategies for motivating students to learn science during their placement. However, what was surprising about the findings is that considering the context within which the pre-service teachers tried to motivate students for learning science; that is, during their professional experience placement, a slightly higher number of respondents (47 out of 52) indicated that the advice from other teachers at the placement school and observing those other teachers played a significant role in influencing their theory of action about strategies to motivate science students. This finding is compared to 41 out of 52 pre-service teachers who believed their supervising teachers played a significant role in motivating students to learn science. Although the difference in the numbers of pre-service teachers choosing the two categories seems marginal (a difference of six pre-service teachers) and still relates to the environmental factors influencing learning within the social cognitive theory, it must be noted that this finding is contrary to research on pre-service teachers' beliefs.

Many researchers have pointed out that pre-service teachers' supervising teachers have potent influences on the formation of pre-service teacher beliefs and practices of strategies in the classroom (Smith, 1997; Hogben & Lawson, 1983). The powerful influence of the teacher is so strong that some other researchers deem it to be more powerful than the influence that the pre-service teachers' university or college supervisors have on the development of their beliefs and choice of the use of strategies (Borko & Mayfield, 1995; Calderhead, 1988; Richardson-Koehler, 1988).

**5.3.2.2. Time Available for Science Lesson Preparation and Lesson Instruction**

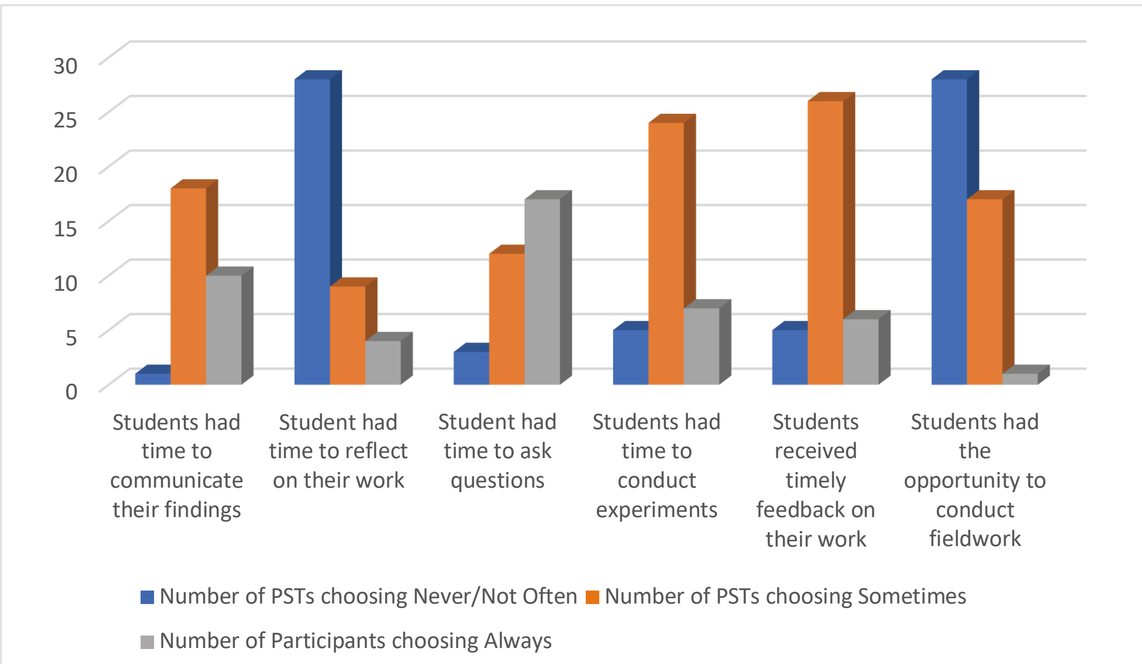
From the data gathered, it was seen that the subcategories, time available for science lesson preparation and time available instruction played a significant role in determining the types of strategies used to motivate science students. Those two sub-factors were espoused by 34 and 43, respectively, out of the total number of 52 respondents. Based on the findings, most pre-service teachers suggested that they used specific strategies to motivate students for learning science during their placement because of a lack of time for instruction. In investigating the pre-service teachers' claims of the influence of time available for lesson preparation and lesson instruction on their choice of strategies for motivating students to learn science, I found it necessary to determine how time either facilitated or hindered the use of specific strategies. This was mainly because of the views of several researchers (e.g., Appleton & Kindt, 1999; Martina et al., 2020; Supovitz & Turner; 2000; Thibaut et al.,2018) who suggested that time was a significant factor that determines what strategies teachers use, how those strategies are to be used when those strategies are to be used, and to what extent strategies should be used in a particular lesson.

Several respondents captured the impact of time on choosing strategies; for example, Respondent # 74 stated, "*The time available to teach these [science] lessons determine the strategy that I will use to motivate my students*." Another respondent, Respondent #3, stated, *"…time available to plan often lead to creating lessons where less planning is needed – e.g. [I give] less scaffolding [during teaching].*" A final example of how time influenced the pre-service teachers' choice of strategies came from Respondent #33, who stated, "*There are times when we have 40 minutes to complete a lesson. This is one of the main factors that determine which strategy I use."* The espoused quotes by the pre-service teachers seem to suggest that they mainly saw the time given for instruction as insufficient to use engage students in strategies (such as the provision of scaffolding) that will motivate them to learn science.

Figure 5.5 shows the number of respondents who chose specific strategies for motivating students to learn science and the frequency of those strategies in their science lessons during their professional experience placement.

**Figure 5.5**

*Frequency of Use of Specific Strategies in Science Lesson Selected by Survey Respondents*




Based on Figure 5.5, one of the strategies that a relatively high number of respondents, 28 out of 52 respondents, indicated that they did not often use was fieldwork because of the amount of time it took to prepare and execute in the classroom. The finding supports studies on challenges faced by teachers when integrating fieldwork in their lessons, completed by researchers such as Baidoo-Anu et al. (2019). Baidoo-Anu et al. (2019) suggest that teachers generally do not have the needed time to organise fieldwork for their students. Research in various science disciplines has found that using field trips as a strategy to motivate students for learning is time-consuming to plan and execute (Tibaldi et al., 2020). The view that field trips as a time-consuming strategy align with the underpinnings of social cognitive theory linked to motivating students within the particular social setting.

Despite the lack of time to plan and execute field trips, the respondents indicated that they understood the importance of using field trips as a strategy to motivate students to learn science. For instance, Respondent # 63 stated, "*Giving students the opportunity to do fieldwork allows them to apply the concepts. They are motivated because they can relate what was taught to real-life situations."* This finding supports researchers who have investigated the value of field trips to education and found that students develop more positive attitudes toward learning and develop increased knowledge on the subject content being taught (Behrendt & Franklin, 2014). Hofstein and Rosenfeld (1996) suggested a positive relationship between the use of informal field trips, where science students engage in casual visits to informal settings, and students' level of intrinsic motivation. Rennie (2014) contends that students become more intrinsically motivated during informal field trips because the interaction is unforced; they would feel at ease in the informal learning environment, thus engaging in more social interactions.

Another strategy that was impacted by the lack of time for instruction and planning was using feedback to the students. Based on the findings, it was surprising that as many as 26 out of 52 respondents stated that they "*Sometimes*" gave students feedback on their work. This finding was astonishing given the importance that education researchers have placed on teachers giving students feedback on their educational tasks (Black & Wiliam, 1998; Hattie & Timperley, 2007; Tuck, 2012). The respondents provided some insight into how time impacted their ability to use feedback to motivate students for learning science. Respondent # 70 asserted that *"The feedback [on students' work] was provided late because the time was not enough [for the lesson]."* One of the aspects that can happen when there is a lack of time for instruction is that teachers may not be able to provide students with sufficient feedback on their learning. This means that the minimal feedback that students may receive may not be sufficient to help them to become confident in their abilities and motivate them to learn science. This was made clear by the quote from Respondent # 70, who stated, "*When students do not receive proper feedback, they lose confidence in their work."* This finding is supported by Selvaraj and Azman (2020), who echoed that giving students feedback on their work is essential and critical for helping develop students' confidence in learning.

Within the social cognitive framework in which this study is framed, it can be noted that providing feedback to students on their academic tasks is vital to motivate them to continue a particular behaviour. Moreover, Selvaraj and Azman (2020) asserted that when teachers promptly provide feedback to their students, this may help enhance students' motivation to learn and their academic achievement. Researchers such as Edgerly et al. (2018), Mandouit (2018), and Wiggins (2012) all conclude that although teachers giving feedback is time-consuming, giving students quality feedback is vital as it can help them become motivated and improve students understanding of the subject matter if given promptly. Because of the social context in which the students learn, they are more inclined to rely on teachers' feedback for social validation and motivate them to learn further.

The findings in this category of the study showed that the limited time available for instruction and planning impacted the pre-service teacher's ability to allow students to reflect on their performances, ask questions and even communicate their ideas during the science classes (see Figure 5.5). This may seem surprising considering the importance of the strategies mentioned earlier for motivating students to learn science. However, when one considers that science lessons do not go on forever and that there is a limited amount of time granted to teachers within which they have to teach the curriculum, it is understandable (Alvunger, 2018; Appleton, 2003) why the pre-service teachers would not have time to employ the strategies; allowing students to reflect on their performance, ask questions, communicate their ideas to their peers, often enough during science lessons to motivate students for learning science.

The pre-service teachers had an awareness of the importance of using experiments for motivating students to learn science even though almost half of them (24 out of 52 respondents) indicated that they did not always use the strategy due to a lack of time. For instance, Respondent # 20 stated, "*Experiments help with student motivation and engagement as well as brings theory into life.*" The results from the web-based survey of this study, therefore, supports science education researchers (Palmer, 2012; Trna, 2012; Williams & Williams, 2011) who have cited the growing importance of using experiments for motivating science students and have agreed that students should be given time to perform experiments in the classroom.

Researchers have noted that the lack of available science instruction and preparation is a well-known issue at secondary school (Appleton & Kindt, 1999) as teachers have no control over the issue because it is set by the school's administration (Samuel & Ogunkola, 2013). However, Samuel and Ogunkola (2013) asserted that sometimes science teachers could negotiate to have alterations to the timetable to increase the time available for their science classes.

***5.3.2.3. Resources Available for Instruction***

Another factor that influenced the choice of the self-reported strategies used to motivate students for learning science was the resources present at the time of instruction. Table 5.2

shows the items that made up this overarching factor and the number of respondents selecting those items.

**Table 5.2**

*Items Making up the Availability of Resources for Instruction Category*

| **Items** | **Number of Respondents (N=52)** |
|---|---|
| Social Media | 37 |
| Availability of Information Communications Technology (ICT) for the science lesson | 31 |
| The type of ICT available for the science lesson | 30 |
| Support from Laboratory Technicians at the school | 17 |

The items in Table 5.2 were further placed into two distinct categories: human resources and material-based resources, with both categories still firmly grounded as environmental factors based on the triadic reciprocality model. The human resource category, a subcomponent of the social factors category of environmental factors, included the item support from Laboratory Technicians at the school, whilst material-based resources included physical material that pre-service teachers used to help motivate students for learning science; for example, charts, graphs, Lab apparatus, ICT enabled device or web-based networks.

Some respondents explained how resources influenced their theory of action about strategies for motivating students to learn science. Respondent #32 stated,

> *The availability of resources to conduct lessons plays a major part in which strategy is used. The more resources available to teach a lesson, the easier it is to include all the students to participate, and they will be excited to learn.*

Based on the quote by Respondent # 32, it can be noted that she made the underlying assumption that if she would be able to include more resources in her science lessons, then she would be able to use a broader range of strategies to motivate students for learning science. This assumption supports the views of several researchers who suggest that a lack of resources can be detrimental to how a topic is taught and the activities that students can be engaged in (Abell & Roth, 1992; Appleton & Kindt 1999; Rowell & Gustafson, 1993). Additionally, considering that the respondents are novice teachers and do not have a solid pedagogical content knowledge (PCK), it is understandable why they would believe that more resources would equate to a more remarkable ability to motivate students for learning science when this may not necessarily be the case. This shows that the pre-service teachers hold a small amount of knowledge about strategies (which they mainly gain through experiences, such as vicarious learning experiences) for motivating students to learn science, which can only be developed as they progress in their teaching career and learn vicariously.

It is also not surprising that the respondents chose some of the strategies to motivate students to learn science because of a lack of resources. Several respondents used demonstration and group work strategies to motivate students to learn science from the survey that was generally not regarded as resource intensive.

**5.3.2.3.1. Using Demonstration as a Strategy to Motivate Students for Learning Science.** As shown in Figure 5.2, the demonstration strategy was chosen by most respondents (37 out of 53) when asked to indicate, *How often do you use the following strategies to motivate students for* *learning science* (survey question 8). Some of those respondents explained their choice to use demonstration as a strategy to motivate their students to learn science. In most of their explanations, respondents acknowledged that the lack of availability of resources in the classroom was a significant factor influencing their decision to use demonstration as a strategy. For instance, Respondent # 35 stated that during his professional experience placement, the demonstration strategy was used to motivate science students when he was "low *on resources*" because it was the *"most economical"* strategy to use considering the lack of resources for his science lesson. Furthermore, Respondent #71 stated that demonstration was used to teach Year eight students the "*pH Acids and Bases*" topic. The respondent explained that the only resources available for that lesson were *"Various acids and bases, litmus paper and charts"* and that *"The charts were used to identify the properties of acids and bases and the litmus test was done for each to determine the category.*" The respondent further explained that the demonstration strategy used during the lesson was a successful one at the time because "*The students were keen on seeing the results of the demonstration."* This finding demonstrates that this respondent successfully motivated students for learning science even though he believed that he did not have a wide variety of resources at his disposal for the science lesson. These revelations by Respondents # 35 and # 37 are important as they are supported by researchers such as Hofstein and Lunetta (2004) and Basheer et al. (2016), who have pointed out the strategic need of using demonstration as a strategy for motivating science students during teaching. A study into using demonstration as a teaching strategy by Basheer et al. (2016) showed that demonstrations could help students increase their curiosity and enhance their reasoning skills.

The data as mentioned earlier, revealed two main ideas. The first idea is that the respondents generally consider the time when choosing strategies such as demonstration to motivate students for learning. The second idea that came out of the findings was that pre-service teachers are acutely aware of how demonstration can be used as a strategy to teach various topics after considering the time resources available for instruction. In relation to the consideration of time environmental factor in the social cognitive theory framework, it can be noted that it is important that students get time to process steps of a demonstration, especially the students they will be required to replicate this demonstration during the science class. Time is also a critical environmental factor determining how well the students replicate a demonstration.

**5.3.2.3.2. Using Group Work as a Strategy to Motivate Students for Learning Science.** The pre-service teachers (36 out of 52 respondents) espoused group work as one of the main strategies to motivate students for learning because of limited resources available for instruction. Respondent # 43 indicated, "*The availability of resources determines which strategy is used. The more resources available, the better. Group activities are used when resources are limited.*" Additionally, Respondent # 75 suggested that she used group work with a Year 8 class during an afternoon science lesson using "*Samples of everyday household chemicals and litmus paper.*" Respondent # 75 suggested that based on the limited number of resources available, *"Students were divided into groups to test regular household chemicals using litmus paper."* Respondent # 75 went on to state that the lesson was successful because "*Everyone was able to share the results of their test with others. Students love to work with their peers*."

Furthermore, the respondent espoused, "*Group work is an effective strategy to motivate students as they are able to work with their peers and have fun while learning.*" This respondent assumed that the use of group work is fun and engaging to students. The responses provided by the pre-service teachers demonstrated that they are aware that group work was an important strategy to use when significant resources were low in the science classroom because students can share limited resources and become motivated to learn. Moreover, concerning using group work as a strategy when resources are low, the quotes from the respondents highlighted a positive outcome of using the strategy in that it leads to students motivating each other to learn the science concepts being taught.

The findings of the study support other researchers who found that the use of group work is pivotal to student learning (Brame & Biel, 2015; Burke, 2011). The findings of this study concerning the use of group work when resources are low do not support the findings of Baines et al. (2003), who suggested that the use of group work as a teaching strategy is more challenging, and more time consuming to plan and execute than any traditional independent learning approach. Baines et al. (2003) also expressed that teachers may not be confident enough to execute group work because they may not have the time and resources needed to help make interactive peer work.

#### 5.3.2.4. Pre-service Teachers' Experiences at Their Current University

Thirty-two out of 52 respondents suggested that their experiences at their current university (ITE program) were a factor that influenced their beliefs about strategies for motivating students to learn science. For this factor, Respondent # 67 was quoted as saying, "*My lecturer usually helps us learn about methods/strategies that we can use to teach science students.*" Based on this quote and the high numbers of pre-service teachers selecting this factor, it can be noted that the pre-service teachers understand their university's place in shaping their theory of action to make them better be able to use strategies to motivate students for learning science. Therefore, I assert that university lecturers in the initial teacher education

(Science Teaching) program play a vital role in shaping the beliefs about pre-service teachers' strategies to motivate students to learn. This assertion supports Ucar's (2012) research, which highlighted that teacher programs play a vital role in developing teachers' beliefs toward teaching.

While the respondents' selection of this category was not surprising, the relatively low numbers of respondents choosing this factor was noted. The number of pre-service teachers suggesting that their experiences at their current university as a factor influencing the strategies that they used to motivate was surprising, considering the strong emphasis that researchers have placed on how teacher training programs; specifically, methods courses, can influence pre-service science teachers' beliefs about teaching (Briscoe & Stout 1996; Hancock & Gallard, 2004; Northfield 1998; Osisioma & Moscovici, 2008).

## 5.4. Summary of Phase One Findings

The web-based survey provided a snapshot of pre-service teachers' theory of action about strategies for motivating students to learn science. I first presented an analysis of the pre-service teachers espoused theories, followed by an analysis of their theories-in-use. The pre-service teachers' espoused theories revealed their beliefs about strategies for motivating students to learn science that aligned with the four principles of motivation. However, it was noted that only one pre-service teacher suggested that giving students autonomy would motivate them for learning science. Regarding the pre-service teachers' theories-in-use, it was seen that they held contemporary/modern theories-in-use. Such strategies included the use of demonstrations, collaborative/cooperative group work and relating science concepts to real life.

The final part of this analysis focused on the factors that influenced the pre-service teachers' theory of action. From this analysis, it was seen that factors such as the pre-service teachers' secondary school experiences, vicarious learning experiences, the time available for instruction, the resources available for instruction, and their university experiences influenced the pre-service teachers' theory of action.

In Chapter 6, an analysis of data gathered from 3 individual cases in Phase Two of the research will be presented. Rich data from lesson observations, semi-structured interviews and documentation are provided to give an in-depth insight into the factors that influenced the pre-service teachers' theory of action about strategies for motivating students to learn science.

# Chapter 6

# Phase Two Findings and Discussion

## Introduction

In Chapter 5, I reported findings from the web-based survey Phase One. The web-based survey data were analysed according to the main emerging themes. This analysis considered the elements of the theoretical framework for this study, which included the social cognitive theory proposed by Bandura (1995) (in Section 2.1) and the four principles of motivation by Turner et al. (2011) (in Section 2.2). This chapter presents findings from the three individual case studies in phase two of this study. The cases involved three pre-service teachers, Paula, Elsa, and Terry, who conducted their professional experience placement at secondary schools in regional NSW. Phase Two of this study builds upon the findings from Phase One by providing a deeper insight into the factors influencing pre-service teachers' theory of action about strategies to motivate students to learn science.

This chapter is separated into two main sections. First, in Section 6.1, the individual pre-service teachers' theory of action is analysed. Within this analysis of the pre-service teachers' theory of action, I first analyse the pre-service teachers' espoused theory, followed by an analysis of their theory-in-use. Second, in Section 6.2, I analyse and discuss the factors that influenced the pre-service teachers' espoused theory and theory-in-use about strategies for motivating students to learn science. The chapter ends with Section 6.3, where I summarise the findings from Phase Two of this study.

I decided to structure the presentation of the findings from phase two of this study in this format to give some immediate context and offer an understanding of what the pre-service teachers' beliefs about strategies to motivate students were; how they enacted those strategies during their placement; and what factors influenced their beliefs about and enactments of strategies for motivating students to learn science. The data analysis relating to pre-service teachers' theory of action was underpinned by the theoretical framework of Turner et al.'s (2011) principles of motivation: Competency, Belongingness, Autonomy and Meaningfulness. Additionally, I considered the social cognitive theory when analysing the factors influencing the pre-service teachers' theory of action about student motivation.

## 6.1. The Pre-Service Teachers' Theory of Action About Strategies for Motivating Students to Learn Science

In this section, the pre-service teachers' espoused theories and theories-in-use concerning strategies for motivating students to learn science will be presented through the lens of the four principles of motivation. In this phase of the study, data about pre-service teachers' espoused theories was gathered using three semi-structured interviews, nine lesson plans and an interview with their respective supervising teachers. Data concerning their theories-in-use were gathered via three science lesson observations per pre-service teacher during their professional experience placements. In every sub-section of this chapter, the findings for Paula will be presented first, followed by Elsa and Terry to represent the order in which data were gathered for phase two of this study.

### 6.1.1. Developing Students' Academic Competency to Learn Science

This section will present how each pre-service teacher who participated in phase two developed students' academic competency to motivate them to learn science. The concept of competency was defined, and an explanation of the strategies teachers use to support the development of students' competency pertaining to teaching and motivating students for learning science was presented in Section 2.2.1 of this study. The definition and discussion of the concept of competency remain throughout this study and are applied to the analysis of data gathered from this research phase.

#### *6.1.1.1. How Paula Helped Develop Students' Academic Competency in Science*

During the data-gathering period, it was noted that Paula demonstrated many ways to help students develop their competency in science. Pertaining to developing students' academic competency to motivate students for learning science, the main strategies that Paula espoused and used during her placement were, offering students scaffolding providing students with feedback on academic tasks. In her interviews and during her science lesson observations that I conducted for Paula, it was noted that Paula believed that scaffolding students during academic tasks are essential. For instance, in her final interview, Paula was quoted as saying, "*You need to give them [students] direction obviously, that is the teacher's responsibility, that they can actually run with it and then have their own very own topic scaffolding themselves.*" In her second interview, Paula acknowledged that "*They [Year 9 students] have got so much to offer and listen to, and you throw them a guided bone but with some minimal scaffolding…*" The two quotes provided by Paula suggested that she knew that giving direction via scaffolding to students was initially the teacher's responsibility so that the students learn how to guide themselves through the remainder of their learning task.

This awareness of the role of the teacher when giving scaffolding is in alignment with the social cognitive theory in which learners are the central focus, and the teachers' role is relegated to a guide or mentor to offer to scaffold to students in the educational setting as they aim to develop a sense of self-regulation. When students are guided and allowed to learn with scaffolding from their teachers, they feel more competent at doing an academic task because of the help they received. As a result of this feeling of level of academic competency experiences when doing a task in the classroom context, students generally become motivated to learn science.

Although the lessons that I observed for Paula did not involve many practical activities with the students, I observed that Paula tried to help students by scaffolding them while they performed tasks during the science lessons that I observed. For example, in her first science lesson, I noted that Paula walked around the classroom from one group to the other to help students record their observations about their mouldy bread on the school's OneNote system. When Paula offered verbal scaffolding to the students, they were more engaged in the lesson, and they appeared to be more motivated to learn by Paula's questions and discuss their observations with each other during the science lessons. Another example of Paula offering scaffolding came from her final lesson, where Paula's primary strategy was discussion. It was observed that Paula offered scaffolding in the form of verbal cues to the students.

Additionally, Paula wrote down keywords that she wanted the students to pay attention to and discuss on the chalkboard. By writing down the keywords and giving students verbal cues, I observed the students being more engaged in the lesson, and they looked more confident to state and justify their claims on the topic of Introduced Species being debated. Paula's use of verbal scaffolding that I observed during her science lesson showed that she understood the importance of using verbal cues to help students become confident in their abilities to perform tasks and eager to learn science. The students' eagerness can be a reliable indicator of their motivation to learn the science topic at the time. The verbal scaffolding,08h referred to as moment-to-moment verbal scaffolding by Hiebert et al. (1996) and Reiser (2004), may help students structure their thinking about a concept to solve problems in the academic setting. Considering the social cognitive framework in which this study is situated, verbal scaffolding is essential for motivating students to learn science. When students receive verbal scaffolding, they may be motivated to persist with a task. For instance, in Paula's case, I noticed that when Paula offered verbal cues to the students during learning activities (e.g., during discussions), the students could respond to questions promptly and tried harder to participate in the learning experiences.

The use of verbal scaffolding to motivate students for learning is debated by education researchers. For instance, this finding of using verbal scaffolding with science students during lessons is supported by studies of science education researchers (Hiebert et al., 1996; Reiser, 2004) who point out the importance of continual verbal scaffolding to motivate students. This side of the debate highlights the importance of the use of verbal scaffolding to motivate students to learn science. On the contrary, many other researchers (e.g., Fretz et al., 2002; Wu & Krajcik, 2006; Wu & Pedersen, 2011) share a differing view about the use of verbal scaffolding and state that the less scaffolding students receive, the more engaged they will be in the learning process as it will help learners develop higher cognitive abilities.

After examining Paula's lesson plans, I noted that Paula did not generally write down in her lesson plans or scaffolding to offer students assistance during practical activities in her science lesson. However, in the final lesson that I examined for Paula, it was observed that she wrote down, in her lesson plan, under the "*Teaching and Learning* section", "*Walk around the class to supervise and assist[students].*" This showed that Paula made a conscious effort to offer more assistance (scaffolding) to students during her science lessons as she progressed in her placement. By placing this note in her lesson plan, Paula demonstrated that she was aware of the importance of creating instructional frameworks to purposively scaffold/assist students during their learning experiences. Although the note in her lesson plan was not specific to how she would help the students or what type of assistance she would provide them, it can be noted that by creating this instructional framework with scaffolding in mind, Paula was able to enact that belief about scaffolding during her science class to motivate students for learning science.

#### *6.1.1.2. How Elsa Helped Develop Students' Academic Competency in Science*

Throughout the science lessons I observed for Elsa, I noticed that she tried to develop students' competency to motivate students for learning science using various strategies. The primary strategy that I noticed Elsa employed was to offer scaffolding to individual students during hands-on/practical activities. During her second interview, Elsa said, *"I think I needed to sort of scaffold a bit more at the start of the lesson, and that might have helped engagement."* In her final interview, she suggested that one of her reading and comprehension lessons was unsuccessful because *"I did not scaffold the* *answers"* to questions she asked during the lesson. These comments shed some valuable insight into the importance of scaffolding to getting students engaged and for Elsa to consider a lesson successful. Researchers are in general agreement, as succinctly expressed by Flick (2000) and Kawalka and Vijapurkar (2013), that teachers have a crucial role in supporting and developing students' curiosity in academia by offering to scaffold to them.

In her second interview, Elsa stated that even though students did not feel like participating in the activity, she would try to get them to participate and offer them assistance by saying, "*I will help you."* and then show the student "*How to complete the activity*". Elsa was very drawn to scaffolding students and stated that "*I think if I help them, cause sometimes it might be that they are not sure what to do, so maybe I will make suggestions of what they can do..."* The realisation by Elsa that students need scaffolding because they may be unsure of what to do during science classes is vital. When students are unsure of how to do learning tasks, they may not partake in the tasks for fear of appearing incompetent to others in the classroom. Teachers may help students become increasingly competent for learning science by scaffolding students through tasks, which may motivate them to learn science even more.

During the lessons that I observed for Elsa, I noted that she walked around the class to offer scaffolding in the form of moment-to-moment verbal scaffolding and hands-on assistance with activities/experiments to the students. For instance, in the second lesson that I observed for Elsa, noted that she was seen walking around to the different groups of students to help them create their wet mounts and set up their microscopes. In the third science lesson that I observed, Elsa and Lorna (Elsa's supervising teacher) were seen helping students collect samples of plants from the school garden to examine them under the microscope in the classroom. In the lesson plan for that third lesson, I noted that Elsa had "*Assist students with setting up and using microscopes"* as a teaching activity. Anytime

Elsa helped the students explain their results or to complete their task, they appeared to be more engaged in the science lessons and more motivated to learn science at the time. This level of hands-on scaffolding, observed for Elsa's case, is vital since students would be more inclined to participate in those practical activities if they know that they will receive support from the teacher as they perform those practical learning activities. As can be seen, by this finding, this level of support provided by Elsa can potentially make students feel comfortable participating in those practical activities and develop their level of competency in the learning tasks, which may motivate them to learn science.

Another way by which Elsa developed students' academic competency was by giving the students feedback on tasks. I observed that Elsa attempted to give students feedback during the lessons that he observed for her, although, during her interviews, Elsa did not mention giving feedback as a strategy for motivating students to learn science. It must be noted that during the science lessons observed for Elsa, although she provided verbal feedback to the students, I did not witness her giving any detailed feedback to the students. For instance, during the lesson observations, I heard Elsa telling students "*Good job*" in the first observed science lesson and using phrases such as "*Awesome*" to the students in her second observed lesson after they completed building their wet mount. Moreover, at the end of the second observed lesson, I noted that Elsa gave the students the exam scripts containing their results and asked whether they had any questions about their exam. Elsa also asked the students, "*Do you think you could have done better?*" For that second lesson, instead of giving the students specific feedback on their performances, Elsa told the students that they generally had problems with the "*The Cells section"* and that they "*Could go over it during revision*." Furthermore, it was observed that although Elsa visited groups during group work, her interaction with the students was based on the task and was seen as procedural; that is, helping students set up equipment and monitor student tasks, rather than giving the students detailed feedback on their attempt at group assignments.

While it is unclear why Elsa did not give detailed feedback to the students on tasks completed, based on her lesson plans, it was noted that she did not especially plan to give the students specific feedback. None of Elsa's lesson plans indicated that she would help motivate students by giving them specified feedback after answering questions or completing classroom activities.

Elsa's supervising teacher, Lorna, shared her opinion on how Elsa gave feedback to the students. Lorna's opinion was contrary to what I observed for Elsa; that is, Elsa gave the students unspecific feedback on learning tasks and admitted in her interviews that she needed to learn how to motivate the students. Lorna believed that Elsa gave the students "*encouragement" and "positive feedback"* during her lessons. Lorna continued to support her claim that Elsa usually gave feedback that motivated the students by saying:

> *When she has asked a question and the students, put their hands up, and before getting one of the students to answer it, she would say, thanks very much, whatever the student's name was, can you answer the question for us?*

Based on Lorna's example of how Elsa used feedback, it can be noted that Lorna believed that when Elsa thanked the students for answering questions, the students became motivated to answer questions.

***6.1.1.3. How Terry Helped Develop Students' Academic Competency in Science***

During Terry's science lessons that I observed, he suggested that he tried to develop students' competency by giving students feedback on their learning tasks. Similarly to Elsa, during Terry's interviews, he did not espouse anything about giving students feedback to motivate students for learning science. During the science lesson observations conducted for Terry's case, I realised that, like Elsa, Terry gave the students unspecific feedback on tasks completed or questions answered during his science lessons. After students were asked questions during Terry's lessons, he would give students collective feedback in the form of unspecific praise, saying, "*Good work, guys.*" One example of this was found in the first science lesson I observed for Terry. During that first observed science lesson, one student volunteered to label a picture of a cyclone on the chalkboard. After the student labelled the diagram, Terry was heard saying "*Thank You*" to the student and "*Good Job*" to the remainder of the students who helped her by telling her where she should place the labels.

Furthermore, an examination of Terry's science lesson plans revealed that he did not explicitly plan to give his students feedback during his science lessons, despite having questions prepared. Because of this type of unspecified feedback, students did not seem very motivated to participate in labelling any more diagrams on the chalkboard during that lesson.

Giving unspecified feedback to the students was shared among all three pre-service teacher cases during their professional experience placement. This finding was not surprising given that those teachers were novices and only learning how to motivate students to learn science through the initial teacher education program.

Moreover, Terry believed that the students would be more motivated to learn science by giving verbal cues during his science lessons. During the first two science lessons I observed for Terry, I noted that Terry walked around the classroom to supervise the students and ensure they were on task, writing notes in their notebooks from his PowerPoint slides. In the first lesson observed for Terry, it was noted that he helped the students label a diagram of a cyclone by offering verbal cues. Additionally, during his third lesson, I also observed that Terry offered students verbal cues to answer questions from the quiz. This was a surprising finding because, in his final interview, Terry stated that he often offered students help during practical exercises to be motivated to learn science. The espoused belief that giving unspecified feedback to students was also observed to be the theory-in-use among all three pre-service teacher cases during their professional experience placement.

### 6.1.2. Fostering Belongingness in the Classroom

This section will present how each pre-service teacher who participated in phase two fostered belongingness in the classroom to motivate the students to learn science. The concept of belongingness was defined, and an explanation of the strategies teachers use to support belongingness in the classroom pertaining to teaching and motivating students for learning science was presented in Section 2.2.2. The conceptualisations of the concept of belongingness remain throughout this study and underpin the discussion and analysis of the data gathered from this phase of the research.

#### *6.1.2.1. How Paula Fostered Belongingness in Her Science Lessons*

The primary way Paula fostered belongingness in her science lessons was by encouraging collaborative/group work amongst the students in the classroom. It must be noted that Paula only mentioned using group work briefly as a strategy in her final interview. In her final interview, Paula was quoted as saying that she used "*…lots of group work"* and *"Lots of group against group [activities]…"* during her placement. Although she did not explain how she used group work as a strategy to motivate students to learn science, I used the observation of Paula's science lessons to provide some understanding of how and why this strategy was used.

One example of group work was highlighted in the first lesson that I observed for her on the topic "*Indigenous Species."* Students were seen working in their pre-assigned groups to observe their mouldy bread during that lesson. In their groups, the students pointed out their observations to one another before they recorded their observations on their OneNote page. Another example of group work was seen in the second lesson, where I observed students helping each other complete food webs by placing which animal feeds on another on their OneNote pages. In the first two lessons that I observed for Paula, it was noted that the furniture in the classroom was prearranged in groups to seat three or four students around a table. When classroom furniture is organised to facilitate group work, it may be easier for the teacher to use that strategy frequently to help students become motivated to learn science (Baines et al., 2008). The use of furniture to facilitate group work is vital and is supported by studies from researchers such as Baines et al. (2008); Chiriac and Granström (2012); Johnson and Johnson (2008), who assert that it is crucial for teachers to ensure that the layout of the furniture in the classroom context is well organised to promote successful group work.

Moreover, the peer assistance/ scaffolding those students provide each other when participating in group work (Vygotsky,1962) can allow them to develop a sense of shared social responsibility (Van Ryzin & Roseth, 2019), and thus students may feel as though they belong in the classroom. In the social cognitive theory context, the social strategy, group work, forms part of the environmental factors influencing learners' learning of a specific concept (Bandura, 1995). Among Paula's three science lessons, the use of group work as a strategy to motivate students for learning seemed to be more structured in the final lesson that I observed. In this final lesson, Paula employed a Jigsaw group work technique where the students worked together in four pre-assigned groups to prepare for a classroom debate. I observed a self-appointed leader in each group who gave other students specific responsibilities, such as scribe, researcher, presenter, and their respective groups. The result of this structured group activity was a well-coordinated and well-articulated discussion amongst the four groups of students, with those four groups, eventually forming two main groups in the classroom (left- and right-hand sides of the classroom), where they appeared confident presenting their work to their peers and the teacher. The allocation of roles to students by their peers when participating in group activities may have the benefit of making students feel a sense of interdependence in achieving shared learning goals (Hare, 1976; Johnson & Johnson, 2008).

When I examined Paula's lesson plans, it was found that Paula planned to use collaborative group work as the primary strategy to encourage and potentially motivate students for learning science during her lessons. In the third lesson plan that I examined, Paula was more explicit about grouping her students for the activity by stating phrases such as:

- *Allocate one species to 2 groups, and groups take a for stance, and the other takes an against the stance*
- *Carry out group research and contribute to collaborative PowerPoint.*

The finding that Paula wrote down her plans to use collaborative group work, although not verbally articulated to me in any of her interviews, was interpreted as part of her espoused beliefs. Additionally, although Paula did not explicitly write down that she would be using cooperative group work as a strategy to motivate students for learning science, based on the context within which the research was conducted and the observations of Paula's theory-in-use, it was implied that Paula intended to use the strategy to motivate students for learning science. It was noted that there was some incongruency between Paula's espoused theories and theories-in-use about using group work as a strategy to motivate students for learning science. This incongruency stemmed because I noted that Paula did not mention the term group work during her interviews, yet it was observed that she used collaborative group work during some of her science classes.

In addition to using group work as a strategy, in her first interview, Paula also espoused that she believed that "*Connecting*" to the students was fundamental to motivating students for learning science. Paula stated that she knew that her idea about connecting to students *"…will change"* when she *"…walk [s] into the classroom because everyone [students] is going to have their own personality.*" Despite her initial apprehension about her ability to connect with the students and being able to motivate them for learning science, in her following interviews, Paula stated that she knew it was important to form meaningful connections with the students during her placement to give the students a sense of belonging and motivate them for learning science. Paula's apprehension about her ability to connect to the students stemmed from her belief that they would see her as a *"Stranger"* since they were not used to her teaching them science. This understanding that everyone has personalities and that connecting to students may not be easy is aligned with the personal factors aspect of the triadic reciprocality model of the social cognitive theory, which reiterates the need for learners' to be understood on an emotional level as well as cognitive level so that learning can begin to occur.

During Paula's science lessons that I observed, it was noted that she intentionally tried to connect with the students by encouraging the sharing of personal stories. In Paula's final interview, she stated that the students "*…had so many stories because I asked them the question; what is your first-hand experience?"* This understanding of sharing stories with students to foster belongingness is fundamental in the social learning theory. When the teacher tells students a story, the students can become aware of various elements of that story that are similar to their situation. This may result in students learning concepts vicariously from the teacher's stories. An added benefit of Paula sharing stories was that the students eventually shared personal or first-hand stories with her in return. This exchange of stories by teacher-student may signify that the students felt connected to the teacher and felt a sense of belonging in the classroom, which motivated them to share their stories. The final benefit from this encouragement to tell stories is that students may also learn vicariously from each other in that way. This finding concerning storytelling is supported by the research of Fawcett and Fawcett (2011), who stated that when persons participate in storytelling, they share their experience, content, and context with others.

Another way by which I noted that Paula tried to foster belongingness in the classroom was by calling students by their names. In her second interview, Paula suggested that she called students by their names because it tells the student, "*Miss cares about me,"* and this feeling would be translated to better engagement in the classroom. Moreover, in her first interview, Paula was quoted as saying, "*I would rather you fail at saying my difficult name. It is a personal acknowledgement that they [students] actually mean something."* Paula's ideas for using the students' names came from her personal belief about persons acknowledging her by name, which consequently informed her theories-in-use during her teaching. Paula's emphasis on calling students by their names during science lessons is crucial because it made students feel as though they were vital to her. As a result of this feeling of importance that the students hold, they may also feel as though the teacher cares about them, which may motivate them to learn science (Bouchard & Berg, 2017).

#### *6.1.2.2. How Elsa Fostered Belongingness in Her Science Classes*

Throughout the science lessons that I observed for Elsa, group work was a prominent strategy that she used to motivate students to learn science. This prominent use of group work as a strategy was because the topics (see section 4 of this study) that Elsa taught lent themselves to hands-on/practical activities. In her initial interview, Elsa stated that she would be "*Trying to manage group work*" during her professional experience placement as a strategy to motivate students for learning science. This espoused belief by Elsa showed that she began her professional experience placement intending to use group work as a strategy to motivate students for learning science.

Despite using group work as a primary strategy during the science lessons that I observed for her, an examination of Elsa's lesson plans highlighted that she did not explicitly plan for group work. The phrase group work was stated only once under the "Pupil Activity" section of her second lesson plan, which read, "*Students move into groups of 3 and set up and conduct experiments.*" The limited inclusion of group work in her lesson plans, despite espousing otherwise, may have suggested that Elsa was comfortable with using the strategy to motivate students for learning science.

During Elsa's lessons that I observed, it was seen that students often worked in pre-assigned groups of three (3) and four (4) to complete practical activities. Despite the use of group work as a strategy to motivate students observed for Elsa in all of her science lessons, in her final interview, Elsa stated that "*Some students, because of social interactions, they did not want to work with a group*" and that in *"One lesson *catapult lesson* one of the students just sat there…."* Elsa showed that she was aware that using group work may not necessarily be an effective strategy for ensuring engagement in their science lesson because students have various personalities and may choose to interact with each other however they choose. This social aspect of learning has a bearing on the environmental factors of the social learning theory, which highlights the importance of teachers considering the social influences that support learning experiences in the classroom. In Elsa's case, she suggested that her students viewed group work as a social setting and that setting will not always lead to students feeling a sense of belonging during science lessons.

Another way Elsa helped foster belongingness in her science lessons was through storytelling, as explained in Chapter 2 of this study. Elsa believed that telling students science-related stories would help her develop a feeling of belongingness with the students so that they would become motivated to learn science. In her second interview, Elsa recounted a lesson that she thought was unsuccessful because she believed that she lacked the confidence to engage the students with stories. In the second interview, Elsa was quoted as saying, "*I am not as confident as someone who has done it for years, so I think that will come with time, that I will get to engage the students more with stories.*" Based on the first science lesson that I observed for Elsa, Elsa shared a story of her personal stories linked to science about her past work as a microbiologist with the students during that science lesson. This story was interesting because it showed that Elsa tried to be relatable to the students by sharing her past work experiences and background. This example from the first science lesson further showed that Elsa understood that she could build a relationship with the students by relating personal stories of how concepts related to her own life. While it was noted that in the lesson plan for that first science lesson, Elsa wrote down that she would tell the students a "*Narrative[story] about my uncle's meter and using the kettle,*" her other science lessons did not show that she planned to use stories as a way to motivate students for learning science.

Additionally, just like Paula, Elsa made an effort to get to know her students while conducting her professional experience placement. During the observations of Elsa's lessons, I noted that Elsa showed that she knew the students' names because she called them by their names and asked them questions about science concepts. At the times when Elsa called on individual students by their names, those students appeared to listen more attentively to her explanations of concepts.

#### ***6.1.2.3.How Terry Fostered Belongingness in His Science Classrooms***

Throughout his placement, Terry suggested that developing belongingness in the classroom was essential to him. During his first interview, Terry stated that he intended to "*Develop a good rapport with all my students.*" Furthermore, in the first interview, Terry was also quoted as explaining that he planned on motivating students to learn by "*having a good rapport with them[students] and delivering content that they are going to be excited to get involved in.*" Terry's second and third interviews reiterated the need to develop a rapport with his students. In his second interview, Terry reiterated that during his placement so far, he had "*Developed a rapport with most[students] quickly, it is more directed at the kids who have not been motivated to work.*" Terry went on to explain the importance of having a good rapport with students by saying,

> *Usually, if I have a good rapport with the kids [students], the kids are generally a little more motivated, or maybe talk to you a bit more or whatever it might be. They generally are a little bit more engaged in what you are trying to deliver.*

During the observation of Terry's science lesson, I got further insight into how Terry tried to build a rapport with his students. It was noted that Terry used language as a tool to build rapport with his students. Terry's interactions with the students showed that he was aware of how using language could create a feeling of belongingness in the classroom. This was evidenced by Terry's constant use of phrases that were aimed at making students feel as though they were an integral part of the science lessons that I observed. Examples of such phrases used by Terry are;

- "*We are going to check light today.*"
- "*There we go, team…let us check out some diagrams.*"

During the science lesson observation period for Terry, I observed that when Terry used those specific phrases to motivate students for learning science, in most instances, the students paid more attention to the concepts that Terry wanted them to focus on. For instance, in the first science lesson that I observed for Terry, he noted that Terry used phrases such as, "*What do we want?" "Do we want to watch tornados?" "We want to do a quick recap"* In the second science lesson, phrases that fostered belongingness that I noted Terry saying included, "*We are going to check light today. We are going through it quick so we can do our dissection" "there we go team, another 30 seconds" We are going to get our Kahoots on".* In the final science trivia lesson, I noted that Terry used phrases such as, "We are going to do Trivia today" "*What have we learnt."* From the quotes noted during the lesson observations, in addition to those espoused by Terry, it can be seen that Terry believed that using phrases to motivate students to learn science was substantial.

This idea to use motivational language/phrases aligns with the environmental factors of the social cognitive theory, which influences behaviour. For instance, when a student is told "*we*" "*there we go team"*, as espoused by Terry, this may make the student believe that he/she belongs in the classroom's social circle and thus motivate them to learn science.

Another strategy that Terry used to foster belongingness in the classroom and motivate students for learning science was cooperative group work. In his final interview, Terry stated, "*My most effective strategy was probably a bit of group work… I think the kids in the class all had great friendships. One thing I did pick up was that they all worked really well collaboratively."* In the first two lessons that I observed for Terry, I noticed that the classroom seating layout did not facilitate collaborative group work. In those science lessons, students were seated at lab tables that faced the front of the class, and they were focused on the PowerPoint presentation that Terry presented during the lesson. There was no cooperative group work being done during those two lessons. During the third lesson, I noticed students arranging the chairs to sit in two pre-assigned groups of four students. I also noted that in that final lesson, the students appeared to be more engaged, which was characterised by the students talking eagerly with excitement about the concepts and consulting with their peers on the concepts to be learnt during that science lesson.

An examination of Terry's lesson plans showed that he encouraged collaborative learning during his lesson. For instance, a look at the third lesson plan revealed that one of Terry's objectives was: *"Provide the students with a game of trivia to act as a revision of content learnt during the topic. Two teams will encourage group work/discussion as well as the use of critical thinking."* For that same lesson, under the "*Pupil Activity"* section, Terry had: "*Work collaboratively to answer questions."* Those objectives in Terry's science lesson plans showed that Terry intentionally thought about collaborative work to motivate students for learning science. The inclusion of those objectives in the lesson plans was not surprising.

During the science lessons that I observed for Terry, it was noted that Terry used storytelling to foster belongingness in the classroom. Although Terry did not espouse any beliefs about using storytelling as a strategy to motivate students, I noted that Terry gave many personal stories related to the concept being taught. In Terry's first lesson, Global Environment, he told the students a story about him experiencing a cyclone in Queensland. Students would stop whatever they were doing during his storytelling and focus on Terry. After the cyclone story, Mary asked, "*Were you scared?"* and then gave a story about when she experienced an east coast low. In his second interview, Terry referenced his first lesson as a successful one because the students were "*asking me questions, just bouncing off me, so I knew I had them engaged or at least interested in what we were learning".* Throughout the lessons that I observed for Terry, he also encouraged students to share their personal stories and experiences about the topic being taught at the time.

### 6.1.3. Giving Students Autonomy for Learning Science

In this section, I will present how each pre-service teacher who participated in phase two gave students autonomy in the classroom to motivate the students for learning science. The concept of autonomy was defined in Section 2.2.3, and an explanation of the strategies teachers use to support the provision of student autonomy pertaining to teaching and motivating students for learning science I presented. The conceptualisation of the term autonomy remains throughout this study and underpins the discussion and analysis of data gathered from this phase of the research.

#### *6.1.3.1. How Paula Developed Students' Autonomy for Learning Science*

During Paula's interviews, she indicated that giving students autonomy to motivate them to learn science was essential. In Paula's first interview, she stated that she believed what motivated her as a science student at secondary school was getting "*independence and freedom to act*" on her ideas in the classroom. As a result of her secondary school learning experience, during her first interview, she stated that "*They [students] are going have stuff to contribute, and I would like to acknowledge that and give them the freedom to act on it if possible*." Although from her first interview, it can be noted that Paula intended on allowing the students to be autonomous in the learning environment during her placement, she said giving students autonomy might "*Be a bit idealistic.*" Furthermore, Paula suggested that she would use her placement as an avenue to "*test"* her "*Ideas, to see if they are working in practice rather than just theorising and putting it in the assignment."* During her initial interview, she seemed unsure how she would conceptualise giving students autonomy during her science lessons. Therefore, it was not surprising that Paula viewed her beliefs about giving students autonomy as idealistic and would test out her ideas during her placement. It was not surprising because education researchers have found that pre-service teachers are more likely to employ more teacher-centred strategies in the classroom when teaching (Woodcock & Vialle, 2010) that limit student agency.

During Paula's science lessons, I observed that there were not many instances of students working autonomously. Furthermore, Paula's lesson plans did not show that she allowed students to be autonomous in their learning because her lesson plans highlighted a very teacher-controlled classroom. For instance, in her lesson plan for the first science lesson that I observed, it was noted that Paula wrote phrases under the *Teaching and Learning* section of her lesson plan, such as:

*a) Direct students to highlight food web*

*b) Direct students to list some affected animals*

*c) Listen to the impacts of pollution*

*d) Write down one fact of cane toads*

*e) Listen to introduced species info*

Based on these plans, it can be seen that Paula's lessons were mainly teacher-directed. For instance, when students do not receive autonomy in the learning environment, they may not be inclined to be motivated to learn science; they cannot construct their systems of meaning (Turner et al., 2011). This predominantly teacher-centred approach that I observed during Paula's science lessons and in her lesson plans was confirmed by Cassandra, Paula's supervising teacher. During Cassandra's interview, she suggested that students were not given much autonomy during Paula's science lessons. Cassandra stated that Paula's best science lessons came about when Paula *"Owned the classroom"* by "*Standing to the front"* of the classroom to have conversations with the students in a "*Controlled way."* Based on her quotes, it can be deduced that Cassandra believed that a teacher-controlled class produced the "*Best lesson*" for Paula. Therefore, it was no surprise that the science lessons that I observed for Paula were mainly teacher centred. It stood to reason that if Paula learnt some of her strategies for motivating students to learn science from Cassandra, Paula might also begin to believe that her "*Best Lessons"* sprung from her ability to control the class and thus not give the students autonomy.

#### *6.1.3.2. How Elsa Developed Students' Autonomy for Learning Science*

In Elsa's first interview, she indicated that she would give students *"A bit of choice in what they look at rather than just this is what you have got to study."* Elsa also stated that she would give students a choice in *"How they conduct the investigations, what tests they do so that they are planning the investigations partly themselves."* In Elsa's lessons, there were fleeting instances where it was noted as giving students autonomy in the classroom. For instance, during the second lesson observed for Elsa, I noted that one student did not want to build a wet mount with other students in her group. In Elsa's final interview, Elsa referenced this by suggesting that sometimes students might not want to perform a group task because of adverse *"Social interactions"* and, as such indicated *"...so maybe I will make suggestions of what they can do."* In that instance, Elsa offered the student who did not want to work with one group a choice to work with her peers or do work in her workbook. In her final interview, Elsa gave an example of her students being given autonomy to work during a previous science lesson that I did not observe:

> *When Year 10 did a WebQuest, I just gave them the websites to go to, and they had to answer questions, and they were all were doing the work; some might be slower than others, but they were not looking at other websites, so that was good engagement. So, I think they enjoyed working at their own pace.*

Elsa thought that by allowing students to work at their own pace or choosing peers to work with, they would become more motivated to learn science. This is supported by Palmer's (2007) suggestion that by allowing students to choose their peers, they would be more inclined to work collaboratively to be thus motivated to learn science.

Elsa's science lessons were observed as being primarily teacher centred. In her second interview, Elsa stated, "*I have not been giving them too much choice,"* The lack of choice given to the students was noted and confirmed during the science lessons observations. For instance, I noted that during the initial stages of her science lessons, Elsa did not give students much autonomy as she would write notes on the chalkboard, which the students wrote in their notebooks. In the initial phases of Elsa's second lesson, "*Making a wet mount,"* she was heard saying, "*Today, you will be creating your slides…We are going to write down what we are going to do today."* Additionally, in Elsa's first science lesson, she gave the students notes about how to build the kettle, and she was heard telling the students, "*The quicker we can get this done, the quicker we can move on to the activity."* The aforementioned quotes suggested that Elsa was of the view that the students would be more willing to complete written notes so that they could go on to their more preferred practical activity.

Moreover, Elsa believed that giving students notes to write in their notebooks served two primary purposes: (1) adding structure to the lesson, Elsa saw it as a way to "*Give structure to the lesson as they come in", and* (2) behaviour management, "*Sort of like a technique to calm them down and get focused."* Those revelations led to Elsa eventually indicating that students did not mind writing down notes because "*They like that they do not have to think, they just write it down."* Despite Elsa realising that the students did not like writing notes, in her second interview, she stated that she knew that it *"was not engaging"* but believed that there "*is a place for it."* Elsa stated, "I am *a student that will study my notes,"* and that when she attended secondary school, she *"Did not have computers that connected up."*

Additionally, Elsa's teacher-centred teaching approach to teaching science was observed in her lessons. For instance, she did not involve the students in her demonstrations. In her second lesson, I observed that Elsa demonstrated to the students how to use various apparatus and explained different procedures that students should do to complete their given tasks. Students were not given any autonomy in finding out what the apparatus was, nor were they given a chance to discover how it worked. Within those demonstrations, there was a teacher-centred approach because although Elsa asked the students two questions about what they were observing, there was no discussion, and the students did not appear to be motivated to learn science. As a result, the demonstration exercises that I observed for Elsa seemed very procedural and prescriptive as she only told the students how to do a specific task. As a result, the students copied/ replicated what they observed Elsa did in her demonstrations during their assigned activities/tasks. During those tasks that followed the demonstration lessons, the students seemed generally not too surprised by the efficient process because they had already seen it happen. This instructive role as a demonstrator is not surprising to Elsa because, in her initial interview, she indicated that she worked as a demonstrator in a laboratory.

***6..1.3.3. How Terry Helped Develop Students' Autonomy for Learning Science***

During his initial interview, Terry espoused that students would be engaged in his science lessons in every way. Based on the science lesson observations I conducted in Terry's class, I saw that he did not allow students much autonomy in his science lessons. Terry's lesson plans highlighted the extent to which his science lessons were teacher controlled. For instance, in the first lesson plan, Terry stated the following Objectives/Pupil activities:

a. *Provide students with a sound understanding of light theory.*
b. *Listen to the teacher*
c. *Watch short YouTube video*
d. *Complete workbook questions*
e. *Ask any follow-up questions*
f. *Pack up workbooks*
g. *Wait for bell*

The phrases mentioned above present in his lesson plans underscored the point that students were not offered many choices in their learning. Although I observed a very structured and teacher-centred lesson plans, Terry did not seem to think his lessons were very structured. He espoused, "*My lessons were not super structured with a bit of everything in them; they were maybe a theory lesson with a fun* *lesson, a practical lesson.*" This lack of autonomy in the lessons was surprising because, during his interviews, Terry stated that he would include the students in his lessons so that they work as a team.

In the first two science lessons observed for Terry, it was noted that when the students came into the classroom, he instructed one student to distribute workbooks to individual students. An examination of his lesson plan showed that this workbook distribution/collection was planned for in his lesson plan as a "*Pupil Activity*", "*Instruct students to collect their workbooks."* During his science lessons, students were required to write down notes in their notebooks and their workbooks. In the first lesson that I observed for Terry, it was noted that at the beginning and middle phases of the lesson, he stated, "*You may be able to grab an answer to the worksheet if you pay attention…I am going to be annoying and ask you to write down step 4. The more information, the better."* While some students seemed disengaged whenever Terry asked them to write notes down, other students seemed to be eager to write down the notes so that they could move on to the videos of cyclones and tornados that Terry promised to show them.

During his second interview, Terry explained the reason for getting students to write down notes during his science lessons. Just like Elsa, Terry suggested that giving students notes has its place in the classroom and that by taking down notes, students can "*Recount them"* at a later date. Terry explained that:

> *I probably would give it a 7/10 again. To be honest, I know that some kids [students], especially one of the young boys in the last class, he takes notes, and I know that he recounts it because I asked him about that. He did such a good job on his yearly exam; he got the top mark of the class, so he learns that way.*

From this quote, it can be noted that Terry believed that giving students notes as a way to motivate them for learning science. Similarly to Elsa, it can be deduced that Terry believed that there was a correlation between students' performance on exams and their writing of notes in class.

### 6.1.4. Making Science Learning Meaningful to the Students

In this section, findings are presented concerning the strategies that were viewed as making learning meaningful to the students to motivate them for learning science by each pre-service teacher who participated in phase two. The concept of meaningfulness was defined, and an explanation of the strategies teachers use to make learning meaningful and thus motivate students for learning science was presented in Section 2.2.4. The conceptualisations of meaningfulness remain throughout this study and are applied to the analysis of data gathered from this phase of the research.

#### *6.1.4.1. How Paula Made Science Learning Meaningful to The Students*

During the science lessons, I observed that Paula tried various ways to make learning meaningful for the students so that they could be motivated for learning science. The main ways by which Paula made learning meaningful to the students were, connecting to the students/making learning relevant, getting to know students and having discussions with the students about the content to be leant.

In the context of Paula's case, it was noted that she used the term connectedness to mean making learning relevant to the students. In her first interview, Paula explained that one of her *"...main things is the connectedness...."* Moreover, in Paula's third interview, she was quoted as explaining regarding connectedness,

> *The evidence of that [connectedness] was I had a lesson, and you were actually present in that lesson, was when I was doing the human impacts and while I was doing all the Australian examples, they [students] were actually really interested. And then when I went into the Amazon, the connectedness got lost, and I only had out of a whole class of 18 kids, there might have been 16 presents that day. There were only two girls that actually engaged with the activity to do with the Amazon, neither of the kids was engaged, and they were actually building upon talking about how kolas are affected by deforestation. They were interested in the quoll because that's an Australian example, they were interested. They were mentioning kangaroos and emus.*

Furthermore, in her second interview, Paula stated that during one of her science lessons, the second science lesson that I observed,

*The key example [of connectedness] was deforestation like in Australia, yea cool, we are interested. [With the] Amazon [rainforest], I lost them, did not even give them a map. I had two girls out of a class of 17 actually tell me animals. That did not work that was not relevant.*

Paula's explanations showed that she was aware that students need to make meaningful, relevant connections with the learning material to be motivated to learn science. This finding is in line with the social cognitive theory, which examines how learning occurs when students can relate the learning material to their contexts, they may be able to understand, find meaning in what is being taught and be more engaged in the learning task(s). For instance, Paula explained that when she gave the students examples of familiar animals and places (that were Australian), they felt more connected to the learning because of the relevance involved. When students do not feel connected to the concept being taught, they may not find meaning in that concept, and as expressed by Paula, they may not be able to relate to what is being taught.

Furthermore, during Paula's second lesson, I observed that she demonstrated connectedness/relevance by showing students pictures of mountains in their geographical area via the use of a digital projector and asked the students to identify the mountains. Some students identified the mountain and began giving their personal experiences about visiting the mountain and the types of vegetation that they observed growing there. By giving the students relevant examples and familiar explanations of concepts during their science lessons, students may feel a sense of relevance developing, and the concept being taught can become meaningful to them because they can relate to it.

Another strategy used by Paula to make learning meaningful to the students was getting to know her students' academic level and students' prior learning, which was essential to consider for motivating students to learn science. In her first interview, Paula stated that it was essential to know the students and *"Where they are currently*." Pertaining to getting to know the students and connecting with them, Paula went on to say:

> *You really need to get an idea of what is their level of knowledge, their level of expertise, what is their current level of skill set to work from, at least rather than just having a set requirement. Just finding out the varying abilities of the kids working from there and looking at connectedness.*

Based on the quote from Paula's first interview, it can be noted that she believed that getting to know students' prior knowledge was necessary for motivating students to learn science. When teachers get to know students' prior knowledge and what they are skilled in, this may allow the teachers to better prepare their lesson plans and use specific strategies throughout their lessons to make the learning more meaningful to the students (Kearns et al., 2021).

During the first lesson that I observed for Paula, it was noted that Paula began her second lesson by asking the students, "*Who remembers the bread?"* This elicitation aimed to connect what students learnt in her previous science class to what the students were about to learn. This elicitation and of revisit students' prior knowledge were also seen in the third science lesson when Paula did a recap of the previous lesson by asking the students, "*What did we do last class?*" *"What can impact the size of the population in an ecosystem?"* During elicitations, it was noted that some students, for e.g. Amari, would raise their hands and say, *"Miss, me*" as they eagerly waited to be called upon to answer the questions. Students' eagerness to answer questions about their previous lessons and prior knowledge may have been because of their ability to recall past learning events. It was noted that during those times when the students' shared their prior knowledge, they appeared to be more motivated for learning science during that lesson.

Paula seemed to regard recapping students' prior knowledge with mixed feelings. Paula mentioned that Cassandra warned her about spending too much time "*on the recap"* of her previous science lessons. Moreover, Paula stated that Cassandra often told her, *"Do not rehash, move on",* after 2 minutes of elicitations at the beginning of her lesson. In her final interview, Paula stated that due to her constant recap, the students eventually became disengaged because "*I kept pushing my program, my agenda, my plan"* and not taking cues from the students or her Cassandra into consideration.

In Paula's third lesson that I observed, I noticed that she conducted planned discussions with the students to make learning meaningful to them. One student from each group was required to explain the stance that they had taken on the topic and justify their group's main points. When asked about using discussion as a strategy to motivate students for learning science in her second interview, Paula stated that "*there is a variation between the two groups"* of students, Year 9s and Year 8s, that she taught. Paula suggested that conducting science class discussions with her Year 9 class seemed effortless to Paula, who said that those students needed "*minimal scaffolding."* The discussion with Year 9 students was contrasting to the Year 8 students, where I observed Paula trying to get them to participate in discussions by constantly cueing them to answer questions. Paula stated that the Year 8 students were "*less autonomous"* than the Year 9 students and had to be *"guided by the teacher"* during class discussions. During Cassandra's interview, she claimed that Paula learnt how to conduct classroom discussions as she progressed through her placement. Paula recognised the importance of using discussion as a strategy to motivate students for learning. Allowing students to have discussions in the classroom about different topics may help students become more motivated for learning as they may gain meaningful insights on concepts from their peers. This learning from this social atmosphere of discussion can be considered as part of the environmental factors influencing learning as expressed by social cognitive theorists (Bandura 1995).

#### *6.1.4.2. How Elsa Made Science Learning Meaningful to The Students*

During the data-gathering period for Elsa's case, I noted that she made learning meaningful by relating science content to students' lives, getting to know students' prior knowledge, and having demonstrations and explanations of concepts.

Elsa made science learning meaningful to students by relating the science content to their students' lives. In her initial interview, Elsa was quoted as saying, "*I think one way to motivate students that I will try to use is bringing in the real world. Why it is important, why would it be important to them and how it relates to their life outside of school."* Elsa's quote highlights her willingness to form an essential link between the real-world concepts that she taught as well as explain concepts to the students because she did not have that opportunity during her secondary schooling. Additionally, based on Elsa's quote, she indicated that making learning relevant for the students was important to her as well.

Elsa's attempts at connecting science concepts to the students' lives were observed during her science lessons. For instance, during the middle phase of the *"Building a Kettle*" lesson, she tried to connect to the previous by telling the students, *"Do not touch the [nichrome] wire when it is hot; it is the same as your toaster."* Moreover, in the final phase of the same lesson, the following brief elicitation was captured:

*Elsa: "Does your kettle at home take 10 minutes to heat up? Why not?"*

Ajani: "*Yes, it is because of the type of metal in the kettle."*

In the first example, at the time when Elsa related the nichrome wire to the students' home toaster, the students demonstrated greater engagement in the lesson by quickly gathering to the front of the classroom to have a look at the nichrome wire that Elsa subsequently showed them. In her initial interview, Elsa stated that during her "*observation days*" from her current university, she *"saw teachers relating it [science content] to real-world experiences"* for the students. As such, Elsa indicated that she was influenced to use the same strategy that she observed during her observation days with her students while conducting her professional experience placement.

In all of the lessons observed for Elsa, it was noted that she tried to elicit the students' prior knowledge. Elsa tried to engage the students and draw out from them, via elicitation, what happened in the previous science lesson that she taught them. At the beginning of the second lesson observed for

Elsa, I noted that she referenced students prior learning when she said, "*You have been given microscope slides before, but today you will be creating your own slides.*" After Elsa said this, one student was heard saying, "*Yay*", while the other students smiled and spoke with an excited tone amongst themselves. In the first science lesson that I observed for Elsa, this level of excitement was not observed amongst the students even when she asked the students, "*What have we been looking at recently. [In] The last lesson, what did we do?*" I observed that only two students answered the questions as the other students were seen taking out their notebooks in anticipation of writing down notes which subsequently followed Elsa's brief elicitations.

Another strategy for making learning meaningful to the students that Elsa used during the science lessons was demonstrations with explanations. An example of Elsa using this strategy was seen in the second science lesson that I observed for her, where she told the students, *"If you come bunch around this area here, I will go through how to make a wet mount."* The students gathered around a table located to the front of the class where Elsa was seated, and Elsa demonstrated and explained how to create the wet mount. Additionally, Elsa demonstrated and explained how a microscope should be used to view a wet mount and how to get the thin layer of the onion skin to be viewed under the microscope. During Elsa's demonstration and explanations, the students were very attentive, and they asked no questions. During their practical component of that lesson, Elsa was seen helping the students set up their apparatus and heard repeating the instructions that she had explained during the demonstration process. Therefore, I noted that this level of demonstration involved attention; students paying attention to the demonstration, retention; Elsa encouraging students to focus on the instructions to replicating the demonstration, and production; where the students reproduced the demonstration to Elsa after following the demonstration and the steps outlined by Elsa. As it pertains to the social cognitive theory, this aspect of learning could be categorised as observational learning (Bandura, 1995). Demonstrations may be an effective way of showing students how to conduct an experiment in science and may have the added benefit of boosting students' confidence in conducting similar experiments later on. Students may believe that if they see the teacher successfully demonstrate how to perform an experiment, they can do so too; therefore, students may become motivated to want to successfully produce experiments (Palmer, 2007).

**6.1.4.3.How Terry Made Science Learning Meaningful to the Students**

During the observation lessons, it was noted that Terry tried to make learning meaningful to the students by making learning relevant, by having conversations with the students and by referencing students' prior learning. Regarding making learning relevant, in his final interview, Terry revealed that he was aware that presenting concepts during his science lessons *"… does not necessarily mean it is going to be relevant to everybody else in the room,"* but he stated that it was important that teachers *"…try to just pick little things in a lesson or in a topic that everybody is getting just a little bit of what they know and what they understand because they make it relevant to their life"* In that same interview, Terry stated that he was aware that "*Many kids these days think that science is not relevant; I am not going to do science when I leave so what is the point?"*

Terry also stated that *"But once they [students] understand that science is relevant always you just got to find where it is relevant to each student."* Additionally, regarding making relevant, Terry continued to explain that "*Once you get to know your kids [students] a little bit better, you can usually start to work out what is going to fit for each one."* The quotes espoused by Terry highlighted that Terry believed that by relevant concepts to students' lives, the learning could be made relevant to them, which could motivate students to learn science. Terry also suggested that for this relevance to happen, teachers may need to get to know their students to make learning relevant to each student whom they teach.

In Terry's science classes that I observed for him, I noted that Terry also tried having conversations with students after conducting elicitations with them in the class. For instance, in the first lesson observed for Terry, he conducted elicitations from the students to stir up conversations with students out about their experiences with storms by asking:

"*Does anyone remember the 2007 storm?*"

*"Has anyone been in a cyclone?"*

During those times, I observed that different students would raise their hands to answer the questions and share personal experiences with cyclones. During his final interview, Terry suggested that students were asked questions during his science lessons to spur up conversations/discussions. Although I did not notice any structured conversations/discussions written down in the lesson plans provided to him by Terry, during the classroom observations, I noticed that several short-lived conversations occurred during Terry's science lessons. Brief spontaneous conversations/discussions occurred after every PowerPoint slide or YouTube video Terry showed the students during the science lesson. In his second interview, Terry stated that in his Global environment lesson, the second lesson observed for Terry, "*There was a lot of group discussion going on",* and that the students were engaged in the lesson.

Moreover, I also noted that Terry made efforts to reference students' prior learning to make learning meaningful to them. This effort to connect students' prior knowledge was noticed in the first science lesson that I observed for Terry. In that science lesson, Terry was quoted as making the following statements to the students.

- *Taking you right back to your convection currents. The experiment you did with the purple dye in the beaker.*
- *Do you remember back to Monday when we were looking at isobars?*

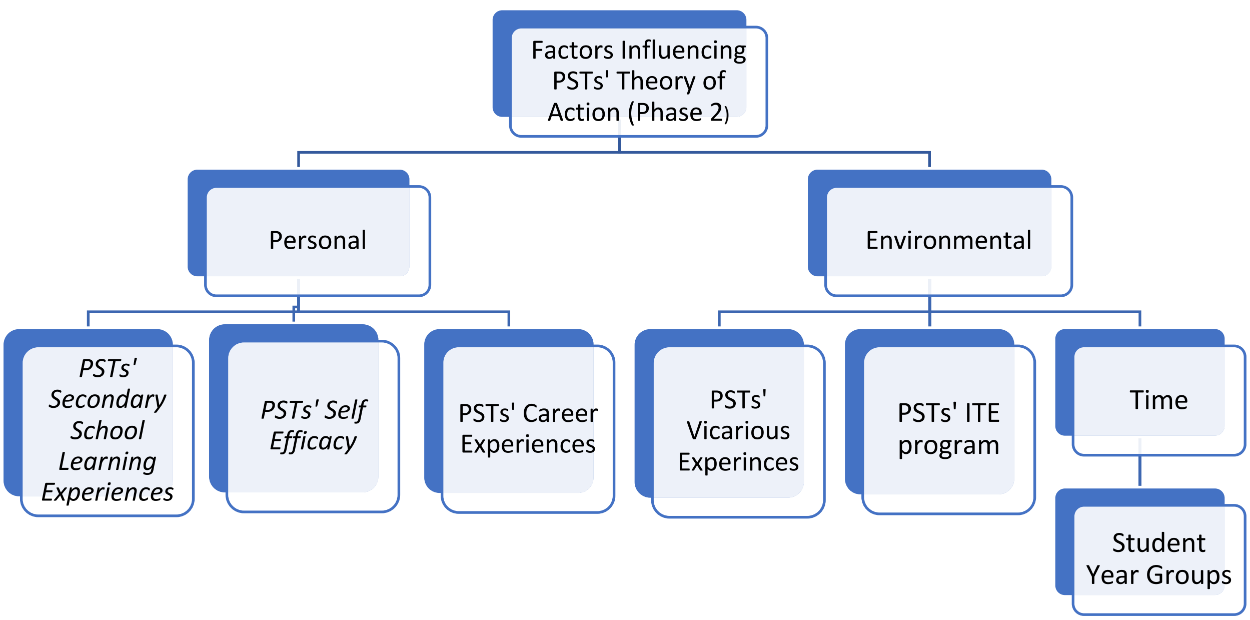
I observed that when Terry referenced the students' prior learning, they were seen and heard talking amongst themselves with excitement and eagerness to give their input in the lesson, indicating a certain level of motivation to learn.

## 6.2. Factors Influencing Pre-service Teachers' Theory of Action

Many factors influenced the pre-service teachers' theory of action about strategies for motivating students to learn science. Those factors were analysed and categorised based on the social cognitive theory (see Section 2.2) and placed into the main themes: personal and environmental factors (see Figure 6.1). These factors, emerging from this phase of the study, will be reported in this Section.

**Figure 6.1**

*Factors Influencing PST's Theory of Action (Phase Two Participants)*




### 6.2.1. Personal Factors that Influenced the Pre-service Teachers' Theory of Action

The personal factors influencing the three pre-service teachers' theory of action aligned with Bandura's (1995) triadic reciprocality model of the Social Learning Theory. The personal factor category involved numerous sub-factors that influenced pre-service teachers' beliefs and behaviours about learning in a given social situation, such as the classroom. In this phase of the study, it was found that the main personal factors influencing the pre-service teachers' theory of action were their secondary school learning experiences, their self-efficacy, and their personal career experiences.

#### *6.2.1.1. Pre-Service Teachers' Secondary School Learning Experiences*

The pre-service teachers' learning experiences during their secondary school was found to have been the main factor influencing their theory of action. This is linked to their personal factors because it is an experience that they directly experience and that is personal to them. Within the social cognitive framework, any experience that persons directly gain is part of the personal factors that form part of the triadic reciprocality model.

In Paula's first interview, she stated,

> *My own learning [during secondary school], I guess, so there is a sense of independence and ownership.… My motivating factor was always when I was allowed to [do work] when I was given the freedom to act on any ideas that I had.*

This espoused belief by Paula suggested that when she was given independence and freedom to work in the classroom, she was better able to be motivated to learn.

The second pre-service teacher in this phase of the study was Elsa, who also suggested that her experience as a secondary school student was a possible influencer on the reason. In her first interview, Elsa stated, *"I think part of it comes from when I was at [secondary] school and probably not having a lot of real-world connections or understanding why we are learning specific things."* This statement was surprising because it would be expected that Elsa would want to teach in the way that she was taught when she was at secondary school, but instead, based on her quote, because she did not get her teachers to relate science to her life, she made it her mission to do so with science students

The third pre-service teacher, Terry, also stated that his prior secondary school experience influenced his beliefs and enactments about strategies for motivating students to learn science. Terry was quoted as saying, *Probably just my experience with school. Being a student, I guess I quite enjoyed my time at school, but I really thrived in high energy classrooms where the teachers were not so authoritative but more created that sore of welcoming environment; a few jokes and the class would laugh, I should not be using the term relaxed environment, but that is sort of what I am trying to bring across.*

The quotes espoused by the three respondents highlight the influence this factor had on their theory of action. The findings of this study are similar to other researchers who agree that teachers are more likely to teach their students in the way they were taught when they were students, especially if they enjoyed their learning experiences (Meske,1987; Pringle, 2006). One such similar study was conducted by Meske (1987), who echoed that pre-service teachers tend to teach as they were taught during their secondary schooling and not as they were taught during their ITE programs. This further highlights the significance of this factor as being one of the most influential factors on the pre-service teachers' theory of action.

***6.2.1.2. Pre-Service Teachers' Self-Efficacy***

The findings from this phase of the study revealed that the three pre-service teachers generally held low self-efficacy about their beliefs and enactments about strategies for motivating students to learn science. For instance, in her final interview, Paula stated that during her placement,

*I kept pushing my program, my agenda, my plan and I could see they were like visibly not 1engaged, and I am like no start to finish, this is what I have sorted out, I am rigid, I am not going to move, this is what I am going to do.*

Paula attributed her *"Lack of flexibility"* during her placement to "*A confidence issue or lack of experience."* Moreover, Paula suggested that *"there has been a little bit of a rude shock to my system on the amount of work required when you are starting out"* and that the placement experience was *"Overwhelming"* at times.

In Elsa's first interview, she stated, *"At the moment, I do not feel as if I have a real set idea…."* Additionally, in her final interview, Elsa stated, "*Maybe I am not as confident as someone who has done it for years, so I think that will come with time."* The quotes by Elsa highlight her awareness of her low efficacy for motivating students to learn science.

In Terry's case, he did not explicitly give details in his interviews about his level of efficacy for motivating students to learn science. However, in his first interview, Terry was quoted as saying, *"I would like to think that they [strategies] would be effective [at motivating students].* Based on Terry's quote, it can be deduced that there was a slight hesitation in his confidence to use strategies that would motivate students because he did not explicitly state that he knew that his strategies would be effective. The pre-service teachers evidently entered their professional experience placement with a low level of self-efficacy, which may have influenced the strategies they use to motivate their students to learn science. Many researchers, for example, Blonder et al. (2014), Palmer (2004) and Jean-Baptiste et al. (2019) have asserted that a teacher's self-efficacy usually is positively related and can directly affect students' motivation levels, the students' achievement levels and the students' self-efficacy as well.

I found that the finding concerning the three pre-service teachers' self-efficacy was both surprising and understandable. First, the finding is surprising because researchers who have studied the self-efficacy of secondary science teachers have all suggested that secondary science teachers generally hold a high self-efficacy for teaching science and about using strategies that can effectively motivate students to learn (Hoy & Spero, 2005; Palmer, 2007; Palmer, 2009).

Secondly, the finding of the pre-service teachers' having a low self-efficacy is understandable because researchers have also agreed that pre-service teachers, because of their newness to teaching, may not be sure as to what strategies can be most effective for motivating students to learn science (Jean-Baptiste et al., 2018). This uncertainty about what strategies the pre-service teachers believed could be most effective in motivating students to learn science may lead to low self-efficacy.

#### *6.2.1.3. Pre-service Teachers' Career Experiences*

The second personal factor that was found to influence the pre-service teachers' theory of action was their career experiences. I noted that the pre-service teachers had careers before they enrolled into their ITE program, and this was one of the influencers of their theory of action about strategies for motivating students for learning science. This factor was categorised as personal because of the pre-service teachers' direct involvement in their career path.

In Paula's case, I noted that Paula stated that her beliefs about strategies for motivating students for learning science stemmed *"Through the course of my career."* Paula was also quoted as stating,

> *I think I will make a good role model, and I think I have a lot of content knowledge because I have got a lot of experience in science class. And then I have got real-world science experiences. I have worked in many labs and stuff like that, so especially with students, I can give them a context out of the classroom.*

Based on Paula's quote, I can deduce that this may be one of the reasons that influenced her theory-in-use observed during selected science lessons throughout her placement. For instance, in Paula's second science class, I noted that Paula tried to talk about endangered species throughout Australia by mentioning mountains close to the students and animals and plant species they may be familiar with. Those examples and explanations of science concepts by referencing the natural world could be seen as offering students real-world science experiences and may serve to motivate students to learn science.

The second pre-service teacher, Elsa, indicated that she had a Doctorate in Science and has a career background as a scientist who had also worked as a *"Demonstrator [for biology labs]"* at her current university. In her initial interview, Elsa stated that during her work as a demonstrator at her current university, she saw "A *first-year Biology course",* and it *"Was really motivating for the students because it is more investigative and really built on teamwork."* Elsa continued to suggest that this teamwork that she noticed in the Biology course "*Was beneficial*" to the students. Although Elsa did not explain how the use of teamwork was beneficial to the students, based on the context of the quote, I deduced that Elsa believed that the use of teamwork/group work would benefit students by getting them motivated to learn science. I noted that in all of Elsa's science lessons that I observed, Elsa placed the students in groups for every activity.

Moreover, Elsa's initial interview shed some light on why she used demonstrations during the lessons by saying that she previously worked as a "*demonstrator in a laboratory.*" An examination of Elsa's lesson plans for the lessons that I observed revealed that she explicitly planned for demonstration in her classes. I observed that in all of Elsa's classes, before any activity, she demonstrated the task that was needed to be done while the students observed and rehearsed the steps of her demonstration. This is in line with the social cognitive theory, which emphasizes observational learning as a significant way by which persons learn (Bandura, 1995). Therefore, in Elsa's case, I noted a link between the factor and its influence on her theory of action about strategies for motivating students to learn science during her professional experience placement.

Regarding the career factor, Terry suggested that his career also had a significant bearing on his theory of action. For instance, in his first interview, Terry stated,

> *I guess for myself, I am currently a full-time swimming coach, so I guess my role in that is to make sure I have a good rapport with the kids and usually if I have a good rapport with the kids, the kids are generally a little more motivated, or maybe talk to you a bit more or whatever it might be. They generally are a little bit more engaged in what you are trying to deliver, so I suppose my number one stance going into placement is to make sure I develop a good rapport with all my students.*

This revelation of how his career could affect his theory of action, given in his first interview, highlighted the importance that Terry placed on this factor. During Terry's lessons, it was observed that

Terry tried to build a rapport with the students by using motivational phrases such as *"Let us go team",* as would be expected from his career role as a swimming coach.

**6.2.2. Environmental Factors That Influenced the Pre-service Teachers' Theory of Action**

The environmental factors that were found to influence the pre-service teachers' theory of action included the pre-service teachers' vicarious learning experiences, their university ITE program experience, time (including time available for instruction, time of day and time of year), student grouping and students' interests. Those factors were categorised as environmental factors because they involved experiences that and events that were beyond the pre-service teachers' control.

***6.2.2.1. Pre-service Teachers' Vicarious Learning Experiences***

This factor involved the pre-service teacher observing other teachers teach and gaining advice from them about strategies for motivating students for learning science.

**6.2.2.1.1. Paula's Vicarious Learning Experiences.** The first pre-service teacher, Paula, suggested that she learnt vicariously in many instances. Firstly, Paula stated that she learnt about strategies to motivate students for learning from her observational days. Paula was quoted as saying, "*I actually have seen it [group work] on my observation placement where especially with the really industrious teachers"* Moreover, Paula stated,

> *In 5 days of observation last semester and observing a whole day of classes and different KLAs, you learn so much, not only in terms of ideas but in terms of strategies, how you show respect to students, how you show sensitivity to students, how you stop situations from getting out of control*

Paula's quote shows that she learnt a lot, including strategies for motivating students to learn science, by observing other teachers during her observation days. The second instance where Paula showed how vicarious learning influenced her theory of action was via reading articles on teaching to learn from them. Paula stated,

> *I was there reading some papers where science teachers have a collaborative environment of learning, then there was another teacher, and he would just keep rearranging the furniture; it is like now you are working in this kind of group, now you are working in that kind of group.*

The use of articles to learn vicariously may be an essential place to learn about best practices and strategies to motivate students for learning.

The final instance that provided Paula with vicarious learning experiences was observing her supervising teacher/ teachers at her placement teach. Paula suggested that her theory of action developed *"…just as a result of watching a teacher that is effective and knows the class well."* For instance, Paula implied that she liked how the supervising teacher used the questioning technique during teaching. In her final interview, Paula was quoted as saying, "*You have got to see this supervising teacher in action, the way she asks those questions, it is just beautiful to watch. It is just so elementary as well."* Additionally, Paula hinted that her use of narrative during her science lessons was because she observed her supervising teacher use the same strategy. Paula stated,

> *The narrative with the Year 8 was something that I saw during observations; my supervising teacher actually utilises it and uses it really effectively. Her narrative is always relevant; it is like and "then you do this… and then you do that" Her narrative is like putting herself in the shoes of those kids. It really works for that year 8 class.*

While I did not observe Paula watching other teachers teach, this was confirmed by her supervising teacher. Cassandra suggested that Paula observe and try to teach like her and even use the strategies she used to motivate students to learn science. Cassandra was quoted as saying,

> *I suggested that I teach again, and then she [Paula] observes my lessons. She [Paula] observed all my first week lessons. We got to the end of the second week that she was teaching, and I suggested that I take a lesson for each of the years just to show her what I have been talking to her about so that I could put it into practice, and she can actually see it unfold and how it worked.*

Moreover, when asked what the main factor was that Cassandra thought influenced Paula's theory of action, she said,

> *Me, I was the factor. I was the factor that kept pushing her in the direction and therefore to look at ways [strategies]because I have got more experience than her… therefore I was able to direct and guide her lesson planning before she got there on how to use those things so that the kids were engaged and motivated along the way.*

Additionally, Cassandra asserted that she also asked Paula to "*Go around to different teachers in different subjects, so they were able to show her their teaching styles. She spent a lot of time speaking to people at sports and staffroom, so she was forever gathering information about strategies*…" and those were outstanding learning experiences for Paula.

**6.2.2.1.2. Elsa's Vicarious Learning Experiences**. *For the second case in this phase, I noted that Elsa suggested that she only observed other teachers based on the advice from her supervising teacher. In her initial interview, Elsa was quoted as saying that her supervisor may want her "…to observe and see how teachers teach and observe a few different teachers and look at how they manage the students and I suppose motivate them [students] as well." Moreover, in her last interview, Elsa stated,*

> *I followed my Year 8 students to English and Mathematics just to observe them. It was mainly to see the teacher. My supervising teacher suggested to go and follow them to Mathematics. That was good just to see how they interact and see different teachers, different strategies those teachers use.*

Based on Elsa's quotes, it can be deduced that Elsa thought it was essential to observe a particular group of students to other classes to observe the strategies used by the other teachers to motivate the students for learning. By observing the same group of students across different subjects, pre-service teachers may understand what strategies motivate students and what strategies do not motivate students to learn.

By understanding which strategies work with the particular group of students, the pre-service teacher can be more deliberate in choosing strategies and better plan learning experiences that can motivate students for learning science.

**6.2.2.1.3. Terry's Vicarious Learning Experiences.** *In Terry's case, I also noted that Terry indicated that his beliefs about and enactments of strategies for motivating students for learning science stemmed from his observations of other teachers teaching during his placement. In his final interview, Terry was quoted as saying,*

> *Being able to go through and observe all the science teachers in any of their year groups, whether it* is *from* Year *7 and all the way throughout* Year *11 and see different strategies that the*y [teachers] are *all using as well…But getting the opportunity to see other people do it and then go *ok that, I might try that next time and see if I can get kids to be motivated.*

The espoused quote given by Terry highlighted the importance he placed on observing other teachers teach the various student year groups. Moreover, Terry justified his observations by stating that teachers "*Have all got very different ways of teaching."* In a similar manner to Elsa, it can be deduced that by observing other teachers teach the various year groups, Terry would be better able to know how which strategy would be best to motivate a particular student year group to learn science.

Terry's supervising teacher, Rebecca, also suggested that she also encouraged Terry to learn vicariously from other teachers. Rebecca was quoted as saying,

> *We are a very collaborative faculty, everybody likes to talk about what we just done what has worked well. So that idea of talking and collaborating with those around you to try and work out what might work better to do the same thing.*

By having a collaborative faculty and being able to learn from other science teachers, teachers may be able to learn best practices from them that they can employ in their lessons to motivate students for learning science.

**6.2.2.1.4. Summary of Pre-service Teachers' Vicarious Learning Experiences.** The three pre-service teachers all suggested that vicarious learning experiences played a significant role in their theory of action about motivating students to learn science. The various quotes indicated different instances of vicarious learning experiences that assisted the pre-service teacher in developing their theory of action. This finding is similar to many researchers who suggest that when pre-service teachers watch another teacher demonstrate how to teach, the pre-service teacher may engage in reflections on their performances, which can lead them to be more intentional teachers and use strategies for motivating students to learn (Hoy & Spero, 2005; Mergler & Tangen, 2010). Moreover, other researchers have highlighted the importance of feedback as a critical source of vicarious learning that facilitates self-reflection (Honigsfeld & Schiering, 2004; Mergler & Tangen, 2010). In Mergler and Tangen's (2010) study, they suggest that critical feedback is crucial as it helps pre-service teachers become more aware of the theory that they were taught, reflect on their skills which can help them develop greater self-efficacy concerning their ability to teach. When teachers' self-efficacy beliefs are high, they may feel confident in selecting effective strategies for motivating students for learning science during their professional experience placement.

***6.2.2.2. Pre-Service Teachers' Initial Teacher Education Courses***

The pre-service teachers' ITE courses were categorised as an environmental factor in the triadic reciprocality model of the social cognitive theory because they involved experiences that the pre-service teachers gathered from social interaction with others, such as ITE staff, who exist in the social world.

**6.2.2.2.1. Paula's University ITE Program Experience.** *Paula suggested that her time spent in courses during her ITE program influenced her theory of action. In her initial interview, Paula stated,*

> *A lot of things in the span of this course had specific things to motivate students. The teachers use a lot of examples. I am sure they consciously do this, but they demonstrate a lot of strategies that I feel that gives really good ideas for how to execute strategies in the actual classroom*.

Based on Paula's quote, it can be noted that the university lecturers purposively demonstrate how to use particular strategies that they expect the pre-service teachers to use in the classroom. Paula elaborated and gave examples of how her ITE program shaped her theory of action. Paula explained that she had "*…one teacher for a psychology subject"* who "*…would always start [her class] with questions*" and during the lesson allow the pre-service teachers to be involved in the lesson by *"…a show of hands and giving credit to our prior knowledge…addressing misconceptions and she would engage us in whatever extra tutorial, and she would ask questions."* Furthermore, Paula explained,

> *A similar teacher who is associated with this placement would demonstrate a lot of how to go about doing group activities. That is really helpful, he would do it over and over again and would show how to form into peer groups, groups by KLA. He has demonstrated really good group working in that sense.*

By learning from her teachers at the university who demonstrate how strategies should be used, Paula may have been able to understand how to effectively use specific contemporary strategies such as group work, questioning, and even addressing students' misconceptions to motivate students to learn science.

Despite the more contemporary strategies Paula espoused that the university demonstrated, I noted that Paula acknowledged, in subsequent interviews, that she may have adopted a teacher-controlled/traditional approach to teaching despite her experiences at university. Paula stated that at the beginning of her professional experience placement, her teaching style was like "*a university presentation*" that resembled "*What the lecturers were presenting to us, PowerPoint."* Paula continued to explain that during the lessons, she used a lecture-type approach. Cassandra asked her, "*What have you got the kids doing?"* In her interview, Cassandra concurred that Paula's unsuccessful science lessons came when Paula used the lecture method. Cassandra explained that initially, Paula did not listen to her advice and stuck to using the lecture-type method and that *"Was never ever going to work."* with her students. What was ironic about Paula and Cassandra's ideas about motivating students to learn science was that although Cassandra may have reprimanded Paula for using a "*university"* style "*lecture"* approach to motivate students, Cassandra thought that Paula's teacher-centred style had produced her most successful lessons. This conflicting stance by Cassandra was surprising because, during the observation of Paula's science lessons, I realised that students generally did not appear to be motivated to learn science when Paula stood at the front of the classroom to teach.

**6.2.2.2.2. Elsa's University ITE Program Experience.** In her initial interview, Elsa stated that in one of her courses at her current university, she partook in a WebQuest that she found to be *"quite motivating."* Additionally, Elsa stated, *"*D*uring my education psychology class, my tutor used Kahoots"* and that this was "*quite motivating and it was fun."* As a result of those experiences, similarly to Paula, Elsa suggested that she would use the strategies she saw her lecturers use in her courses to motivate students for learning science during her professional experience placement.

**6.2.2.2.3. Terry's University ITE Program Experience.** *The factor: university ITE program experience did not appear to influence Terry's theory of action. During Terry's second interview, he was quoted as saying,* "*I am going to university every day, being told what I should be doing, and it does not necessarily work like that in the classroom." Based on this quote, I asserted that Terry realised that there was a discrepancy between what he is taught at the university and the strategies that he uses to motivate students to learn science during his placement.*

Furthermore, Terry stated that "*Unfortunately, guess what? You have been at university for a couple of years you do not know everything."* The aforementioned quote by Terry seems to suggest that although he learnt about strategies for motivating students at his current university, he recognised other factors as being more influential on his theory of action.

**6.2.2.2.4. Summary of the ITE Program Experience Factor**. A pre-service teacher's ITE program is a major factor influencing choice of strategies for motivating students for learning science. While in Terry's case, he believed that there was a disconnect between the theory taught at the university and its practical application in the classroom, the other two pre-service teachers suggested that their ITE program was helpful to them. Courses within the ITE programs may help pre-service teachers become aware of strategies that have stood the test of time and have been proven by science researchers to motivate students to learn science.

While the finding concerning this factor provides an understanding of how pre-service teachers can develop their theory of action, this finding is different from that of researchers who claim that while ITE programs may help pre-service teachers enter the profession with certain beliefs about strategies to use in the classroom, it cannot produce the finished article [teacher] since there are so many other factors that may influence teachers' beliefs and actions in the classroom environment (Hart, 2000, 2013; Rouse, 2010). This, therefore, can serve as a justification for Terry's suggestion that there may be a practice-theory divide that exists in the ITE program.

#### *6.2.2.3. Time*

In this category, I placed any reference of time (both temporal and scheduling) that influenced the pre-service teachers' theory of action. Based on the pre-service teachers' espoused quotes and their theory-in-use, I noted that the two main subcategories under this time factor were time available for instruction and time of day in which the lesson was conducted. Moreover, unique to Terry's case, it was noted that the time of year in which she conducted his placement influenced the strategies he used to motivate students for learning science.

**6.2.2.3.1. Time Available for Instruction.** *In this category, I observed that the pre-service teachers generally run out of teaching time. In Paula's second interview, she stated,*

> *I gave them [students] selected topics [to discuss] because I knew there were time constraints, I knew I had not given them much time. So, here is your information, you guys process it now. Here is your information, you guys discuss it now.*

Furthermore, Paula said, "*Because I did not want too much time to be spent on the activity, I gave them [students] a very scaffolded observation*." The quotes by Paula demonstrated that she moved from contemporary strategies to more traditional type strategies because of the lack of time available for the science lesson. As Paula states frankly, during her science lessons, *"There was not enough time."*

During the lesson observations for Paula, I noticed that there were instances where Paula rushed the students to complete activities because of a lack of time. I noted that Paula always placed time limits on the students during their classroom activities. For example, during her lesson on *Introduced Species*, Paula was heard saying phrases such as:

- *I will give you a minute [to research]*
- *You have had a minute or two to discuss*
- *Within the time constraints I have given you, a quick sum up is advisable*

In instances where Paula gave the students set times to complete tasks, some students were seen quickly discussing concepts amongst each other or individually researching concepts on their ICT enabled devices. Other students were seen sitting idly in their seats, seemingly not motivated and uninterested, while watching their peers rush to complete the prescribed activity that Paula gave.

An examination of Paula's lesson plans revealed that Paula was very focused on the time available for instruction. For instance, in her first lesson plan, Paula wrote down students would, under the *Teaching and Learning* section, "*Fill in the blanks if time permits."* When comparing this to her second lesson plan, it was noted that she wrote that students should be able to "*Answer quick questions"* about the topic being taught. Moreover, based on her lesson plan, it was noted that Paula planned the amount of time that the students would have for research in the classroom. For instance, in the third lesson plan, Paula wrote that she would "*Allow 5-7 minutes research time"* during the research activity before presenting their findings to the class. Furthermore, based on the time allotted to individual tasks such as "*Watch video--- (3 minutes*)" in her first lesson plan, it can be deduced that Paula planned the amount of time it would take for her to play every video for the students during her science lessons. Paula's focus on the limited time available for instruction seemed to have detracted her from allowing students to be autonomous during science lessons or using more accepted contemporary strategies (e.g., Field Trips, Experimenting) for motivating students to learn science.

For the second pre-service teacher's case, I noticed that Elsa most times ran out of time to teach the students as the bell would ring. During those times, it was noted that Elsa would tell the students to read up on the topic that was part of their homework. Regarding Elsa's lesson plans and the during the interviews, I noted that Elsa did not focus on making the time available for instruction, the main issue influencing the strategies that she used to motivate students for learning science.

In Terry's case, I also noticed that Terry did not espouse that he considered time a factor influencing his theory of action about strategies for motivating students to learn science. This was different from the science lesson observations that I conducted for Terry. During the lesson observations, I noted that Terry would typically use phrases such as "*30 seconds guys"* and place time limits on activities he gave the students to do.

When students feel as though they are rushed during their science lesson, they will not be motivated to learn. Students may not be able to take their time to construct their systems of meaning or to engage in social negotiation (Vygotsky, 1978) properly. Moreover, with the lack of time available for instruction, the teacher may not be able to give students scaffolding on classroom tasks, nor will the teacher be able to give students detailed feedback on their performances on tasks. As a result of this lack of detailed feedback, students will not feel properly supported in their learning and thus will not be motivated to learn science. Furthermore, the teacher may tend to resort to using more time economical and traditional strategies; for example, as seen in Paula's case with her planning for fill in the blanks and giving scaffolded observations to the science students. This lack of time available for instruction to perform those aforementioned critical learning tasks may allow students to feel disengaged in the learning environment. This finding bears similarities to other researchers (e.g., Farbman, 2012; Rivkin & Schiman, 2015) who suggest that when teachers have more instructional time, they may be able to cover more material and examine topics in greater depth which may allow them to be able to engage in differentiated instruction and give students feedback on questions/misconceptions that they may have during the learning process. This level of engagement with students in differentiated instruction and the provision of feedback to students will make them feel more confident when learning science, and this can directly translate to the students becoming more motivated to learn science.

**6.2.2.3.2. Time of Day.** In this category, the pre-service teachers indicated that the time of day they taught influenced the type of strategies used to motivate students to learn science. In Paula's case, Paula stated regarding the time of day, *"It is a big one. The kids are making me notice that actually, cause like they come in all hot and flustered after lunch and stuff like that*, *and then they try and take me for a ride."* Moreover, in her second interview, Paula was quoted as saying, "*The time of day really favoured me today because you were still in that morning block and then the end is in sight, it is not like uh,* I have *got to go to another class."* Based on Paula's quotes, it can be seen that she had a general awareness of how the time of day can influence strategies that she would use for motivating students to learn science.

During the final interview for Elsa, she gave an example of how the time of day influenced her choice of strategies for motivating students to learn science. Elsa was quoted as saying that for one of her lessons, the Year 7 students were *"…were really good last period on a Friday, but a second period* *earlier in the week they just were crazy…."* Moreover, Elsa stated that she was really surprised with her Year 7 class who "*Made a model cell out of plasticine and it was a fifth-period class, the last period, and they all did beautiful work."* Furthermore, Elsa indicated that because of the time of day, "*My supervising teacher thought it [the lesson] might go pear-shaped."*

In Terry's case, he stated that during one of his afternoon classes, "*It was like bashing your head against a brick wall, trying to get content out of them"* as such had to "…*give them other things that would excite them to learn rather than giving them something that was not a bit boring, I suppose."* Moreover, in his second interview, Terry indicated that regarding a Friday lesson that he conducted after lunch, *"I do not think they [ students] were really motivated to do anything"* because *"They [students] get a little bit tired"* From this quote, it can be noted that Terry also realised that the time of day influenced the strategies he used to motivate students for learning science.

The time of the day in which science is taught may influence the strategies used by science teachers to motivate students for learning science. For the three cases, it appeared that when science lessons were held during the morning, the pre-service teachers were more confident that those lessons would be successful compared to lessons conducted during the afternoon. It was noteworthy that the pre-service teacher who seemed to have been having successful science lessons in the afternoon was Elsa, after engaging students in practical activities. This finding supports studies by researchers who suggest that students may have mental fatigue in the afternoon, and it would be best to allow students to partake in practical tasks during the afternoon classes (Gates, 1916; Jones, 1992).

**6.2.2.3.3. Time of the Year.** Another aspect of the time factor that was unique to Terry's case was that Terry and his supervising teacher mentioned the time of year as significant in determining the strategies that Terry used during his placement. For instance, in her interview, Rebecca stated

> *One of the main problems is the time of year at the moment the kids have all finished their yearly exams, in their mind, they think that school after they finish their test, does not matter anymore,*

> *they think they are finished, so needing that extra motivation to try and find different ways to get them involved.*

Furthermore, Rebecca stated that "*Sometimes at this time of year even the seniors are becoming disengaged…having to come up with new strategies has really been quite difficult for him [Terry]…"*

In addition to the explanations provided by Terry and his supervising teacher concerning the time of year, I also noted that during the science classes that I observed, Terry seemed to be trying very hard to find strategies to motivate students for learning science. This further highlights the importance of this factor in determining what Terry believed would be effective strategies for motivating students to learn science. The time of year in which students are taught can have an enormous effect on the strategies used by a teacher to motivate them. Students may be more motivated to learn science at the beginning of the school year than they would at the end of the school year when they have completed their yearly exams.

**6.2.2.3.4. Summary of the Time Factor.** The environmental factor: Time was noted as being one of the most influential factors influencing secondary science pre-service teachers' beliefs about and strategies used for motivating students to learn science during their professional experience placement. More specifically, the findings of this study uncovered that time available for instruction, time of day and time of year as the three subcomponents of the time factor that influenced the pre-service teachers' theory of action. This finding is similar to the research by Jones (2009) and revealed that the time for science instruction could vary from teacher to teacher, from week to week, as well as the time of the year in which the science lessons are also conducted. Jones (2009) suggested that when teachers devote time to science instruction, teachers can become more confident in their science knowledge and the strategies they use to teach students science, and this may have the added benefit of improving student learning in science.

#### *6.2.2.4. Students' Year Groups and Students' Interests*

Students were categorised as an environmental factor in the triadic reciprocality model of the social cognitive theory because they are part of the social environment that pre-service teachers must consider when planning learning experiences. In this phase of the study, the main finding concerning students was getting to know students, including their names, interests, and what they know. In Paula's case, she stated that *"I had certain ideas [about strategies], but you still have to modify [your strategies] according to what works with a particular group of kids [students]"* Based on this quote, it can be noted that Paula thought that it was important to use strategies taking into consideration how well it will motivate a particular group of students to learn science. Additionally, in Paula's final interview, she stated that *"the strategies varied"* based on the student year group that she taught. For instance, Paula stated that because of her current knowledge of the different student groups that she faced, she believed that the use of narrative as a strategy with the Year 8 students worked really well. Paula stated that

> *The evidence for that was on my last lesson with them, we were talking about natural disasters and how affect ecosystems and in a lesson that was not overly prepared for, I had so much input across the board from those kids. They had so many stories because I asked them the question, "what is your first-hand experience?" we went through fire, we went through drought, and we went through the flood. They had a lot of input, and I had input from kids that don't normally have input as well.*

With her Year 9 students, Paula stated that she found that the strategy discussion *"Works really well with them and it needs to be scaffolded. You need to give them direction obviously, that is the teacher's responsibility, that they can actually run with it and then have their own very own topic scaffolding themselves."* For her bottom Year 8 students, Paula stated that "*They loved to mix it up, and they are very tactile, so they like to have hands-on practical activities. They respond really well to that."*

Based on the explanations given by Paula about how she engaged the different student groups, I deduced that when a teacher uses specific strategies for a particular group of students, this may send the message to the students that the teacher consciously is aware of the strategies that can motivate them for learning and thus the teacher may choose learning material that may make the learning meaningful to those students.

The second pre-service teacher Elsa also suggested that she used different strategies to motivate different year groups of students to learn science. Additionally, Elsa stressed that she believed that "*I think if you knew your students and knew what they were interested in and even their learning difficulties",* then teachers would be better able to motivate them for learning science. Furthermore, Elsa gave an example of how not knowing students can affect their motivational levels. In her final interview, Elsa stated that for her Year 8 students

> *When they sense the lesson too hard, they just sort of gave up a bit, so I think the strategies are important, but you also have to know your students. And you have got to target the lesson to that level so they can achieve it.*

Elsa indicated that before her placement, she did not have access to the school's central system and was not able to gauge each student's academic level. She was quoted as saying, "*I would have been good to have more access [to the school's central system] or take a look at the level where the students are…"* before she started her professional experience placement.

In Terry's case, he stated, *"I think that you need to get to know them, know the kids, get to know how they learn, get to know their interests. Then find ways you can motivate the students through that."* Cassandra echoed Terry's belief by stating that it is important to "…*get to know your kids [students], find out what interests them; even what interests them outside the school. You are going to start to get to them better, what are their extracurricular activities, what do they like to do?"* Cassandra went on to give an example of how knowing the students in the various groups can lead to pre-service teachers' using strategies for better motivating students to learn science. For example, Cassandra stated that

> *The Year 9 class are a really mixed ability group. We've got some who have very low literacy and numeracy skills, and then we have got others who are borderline A stream, they are really quite smart kids. So having to look at the strategies within that room is very different from the Year 10 where the Year 10s are all kinda bunched middle ability, group of kids who are very vocal, likes to and participates quite a lot.*

Moreover, Cassandra stated that *"For example, the Year 9s are great with Kahoots, Year 10 students got bored with them quickly, and he had to think of something different to do with that group [to motivate them]."* The numerous explanations given by Cassandra showed that, as a supervising teacher, she supported Terry's understanding of how knowing students' various year groups can influence the strategies that Terry used to motivate students for learning science during his professional experience placement.

## 6.3. Overview of the Three Pre-service Teachers' Theory of Action

In this section, an overview of each pre-service teacher is provided. This section provides a synopsis of the three pre-service teachers' theory of action and the factors influencing their strategies for motivating students to learn science during their professional experience placement. This synopsis further provides an additional context for understanding the findings considering my analytical framework of the social cognitive theory and the four principles of motivation.

### 6.3.1. Paula's Case

The findings from Paula's case revealed that Paula tried to motivate students for learning science in several ways. While Paula's ideas about strategies to motivate students for learning science were not surprising because of the context of her professional experience placement, what was surprising and ironic at times was the confluence of personal and environmental factors that influenced her choice of strategies. Paula's supervising teacher, categorised as an environmental factor, seemed to have the most influence on the strategies that she chose to motivate students for learning science, although there were times when Paula's beliefs about how to motivate students differed from her supervising teacher's beliefs.

The findings for Paula's case revealed that the success of strategies she used to motivate students for learning science varied based on the students' year level, with discussion and group work being the prominent strategies for motivating Year 9 students. The lower student Year levels seemed to have been motivated when they were introduced to hands-on activity and given a chance to talk about their personal experiences and prior knowledge on the topic at hand. A surprising finding for Paula was that although during her first interview she espoused that she would involve the students as much as possible in her science lessons, I observed that her science lessons, especially with the Year 8 students, were generally teacher centred. Despite this teacher-centred observation, I noted that Paula gave scaffolded teaching to the Year 9 students who had a little bit more autonomy during their science lesson. Moreover, the time available for instruction seemed to have been another powerful influencer on her choice of strategies for motivating students for learning science during her placement.

### 6.3.2. Elsa's Case

Elsa's case provided insights about where her ideas for motivating students to learn science came from and the strategies she used to motivate science students. The findings showed that Elsa seemed to have a love for science even during her time at secondary school. It was surprising that the main strategies, group work, discussions and relating science concepts to students lives, which Elsa espoused to motivate students to learn science were strategies that she wished she had experienced during her secondary schooling. During the science lesson observations, it was also surprising to see Elsa giving students notes to write in their books, and Elsa stated that it was important for students to take down notes even though the students did not seem motivated to learn science when they wrote down notes.

The findings for Elsa's case also showed that although Elsa placed heavy emphasis on hands-on practical tasks, during her science lessons, I observed that her science lessons were generally teacher centred because she expected the students to do what she asked them to do in the way she told them to do it, not allowing the students to deviate from her instructions. Her task-oriented nature meant that I observed Elsa visiting groups of students during practical activities to offer feedback on the task instead of how the student was progressing through the completion of the assigned task at the time. Moreover, Like Paula, Elsa espoused time as a factor that influenced the strategies she used to motivate students for learning science. However, unlike Paula, Elsa indicated that the time of day in which she conducted her lessons influenced the strategies used to motivate students.

### 6.3.3. Terry's Case

Terry's beliefs about how students should be motivated for learning science came from numerous sources. Although Terry espoused his beliefs about main strategies such as using group work, discussions, practical hands-on activity for motivating students to learn science, I noticed that this was incongruent with his theory-in-use. The science lessons that I observed were mainly teacher-centred, with Terry using a traditional lecture-style method in two out of three observed lessons. Terry was very good at motivating students for learning science by using verbal cues that gave students a feeling of inclusion and belongingness in the classroom, but I noticed that this was overshadowed most times by the generic, unspecified feedback that he gave students during his science lessons. Additionally, the main factors that influenced his choice of strategies used to motivate students for learning science were the time of year, time allocated for instruction and his career as a swimming coach.

## 6.4. Changes in the Pre-service Teachers' Theory of Action

The findings from phase two of this study revealed that secondary science pre-service teachers' theory of action was subject to change. I believed that it was imperative to gather data about pre-service teachers' theory of action with participants from Phase Two because those were the only participants that he got to observe enact their espoused beliefs about strategies for motivating students to learn science during their professional experience placement. This level of triangulation, coupled with interviews with their respective supervising teachers, allowed me to better understand how and to what extent the pre-service teachers' theory of action changed during their placement. The findings from this phase revealed that pre-service teachers generally held a traditional theory of action when they began their professional experience placement. However, during the professional experience placement, I concluded that although the pre-service teachers' theory of action was traditionally in nature, this traditional theory of action changed to becoming a more contemporary theory of action by the end of the placement period, as evidenced by the following sub-sections. Argyris and Schon (1974) indicated that one's theory of action lies on a continuum, and this was supported by Dewey (1938) in his early years, who posited that a person's belief system could either be categorised as being traditional or contemporary. In this study, I note that although the pre-service teachers' theory of action was classified as being traditional or contemporary, this did not mean that the pre-service teacher only espoused and demonstrated traditional or contemporary strategies for motivating students for learning science. There was enough evidence gathered from the data to uncover how pre-service teachers' theory of action changed during their professional experience placements, as explained in the next sub-sections.

### 6.4.1. How Paula's Theory of Action Changed During Her Professional Experience Placement

Paula's theory of action about strategies for motivating students for learning science changed during her professional experience placement. In Paula's first interview, she gave an inclination that her beliefs about strategies for motivating students to learn science would change when she stated*, "At the* *moment I figured everything [belief about strategies] is a bit hypothetical…but I know that will change when I walk into the classroom because everyone [students] is going to have their own personality."* During the science lesson observations that I conducted for Paula, I noted that Paula's theory-in-use gradually shifted from being teacher-centred; with her being at the front of the class mainly during her first science lesson, to being more student-centred, which was seen in her last science lesson. In her last science lesson, Paula was seen placing students in four groups and allowing them time to use their media devices to research the pros and cons of having invasive species of plants and animals in Australia. The students were required to debate and justify their stance on the topic by giving examples and empirical research. During that lesson, Paula offered verbal cues that encouraged and facilitated the debate amongst the students at the time.

The strongest indications that Paula's theory of action changed during her professional experience placement came from her final interview and her supervising teacher's interview. In her final interview, Paula explained in detail how her beliefs and enactment of those beliefs about strategies for motivating students to learn science changed during her placement. Paula also gave the main reasons for changing her theory of action from traditional to student-centred. For instance, in Paula's final interview, the following quote was captured.

> *Now I would say that one of the key things is get to know the kids and build bonds with them, even if it is like knowing their names, personal acknowledgement, acknowledging their contributions. I had a lot of ideas about the ideal classroom and the ideal strategies and how I should prepare material before the professional experience placement, but that is 50% or less than 50% of the equation, but the other part is there is no point if you do not actually bother to know your kids.*

Moreover, Paula espoused that she *"Was making a lot of mistakes of preparing, dumping the information, and not making them [students] do anything."* Paula also suggested that she was *"more* *self-focused"* and viewed her placement as a "*university assignment"* with *"presentations and worksheets*" that she needed to get done. Paula also stated that she came to the realisation that *"It is not about what I want. Of course, I have to do alot, but I also have to get to know my kids."*

Based on Paula's quotes, it can be seen that she reflected on her theory of action before and after her professional experience placement. Based on this reflection, it can be noted that there was an element of change in Paula's espoused belief and her theories-in-use about strategies for motivating students to learn science. The quote showed that Paula's theory of action generally shifted from a traditional standpoint; characterised by her dumping information on the students, to a more contemporary stance; where she realised that getting to know students was important.

In addition, Paula's supervising teacher confirmed that Paula's theory of action changed. In her interview, Cassandra was quoted as saying that Paula,

> *She [Paula] got more confident and more knowledgeable of the students. The syllabus says know students and how they learn, so she, by the end of it, was able to do that a lot better than what she did at the beginning of it. She was able to be more comfortable in the classroom, be more confident, and that comfort and confidence allowed her to know her students better so that she knew where to pitch things and what they might enjoy, what angle to go for things and things like that.*

I observed that Paula adopted a more contemporary theory of action was confirmed by Cassandra. This shift in the theory of action noted for Paula was not surprising because, based on her first interview, Paula suggested that she would be willing to change her beliefs and how she enacts her beliefs about strategies for motivating students to learn science during her placement. This was not surprising in light of Pajeres's (1992) claim that teachers' beliefs are considered the strongest predictor of their teaching behaviour. This tentative belief that Paula held at the beginning of her placement was seen by her willingness to adopt more contemporary approaches for motivating students to learn science

Moreover, what was notable in Paula and Cassandra's interviews was that they both believed that Paula's theory of action changed when she got to know the students' names, interests and diverse learning needs (discussed in Section 5). Paula also suggested that getting to know the students and planning for their diverse learning needs as of critical importance.

### 6.4.2. How Elsa's Theory of Action Changed During Her Professional Experience Placement

Elsa's theory of action was predominantly traditional in nature. This predominantly traditional theory of action was surprising considering that there was a mismatch most times between what Elsa espoused in her interviews and her theory-in-use I observed during her placement. For instance, at the beginning of her placement, Elsa espoused mainly contemporary strategies for motivating students for learning science. In her first interview, Elsa was quoted as saying, *"I think one way to motivate students that I'll try to use is bringing in real-world: Why it's important? Why would it be important to them? and how it relates to their life outside of school*?" Furthermore, Elsa stated that "*I probably would use a lot of hands-on investigations, practical work because I know students are motivated to do them."*

In her second interview that was conducted during the middle of her placement period, Elsa was quoted as saying

> *You still have to get them [students] to write notes. You want them to have notes in their book. I think writing notes has a place, but it's just working out what the class, what level and how much writing that class can do.*

This quote stood out because it deviated from her initial espoused beliefs about strategies for motivating students to learn science. This discrepancy between what Elsa initially espoused and her theory-in-use I also noted in all classes that I observed for her.

In her final interview, Elsa stated that her beliefs about strategies for motivating students to learn science remained the same throughout the duration of her professional experience placement. This was confirmed when Elsa stated,

> *I think in some ways it is the same. I know the different strategies, like doing practical activities, keep mixing up the lesson into different activities, but I still have that now from when I started. So, my beliefs are almost the same.*

Elsa suggested that if she had enough time to get to know the students to "*do multiple strategies per lesson to meet the learning need of each student",* her beliefs about strategies to motivate students may have become more contemporary. Elsa stated that

> *I suppose, getting to know your students. In 4 weeks, I did not. I got to know them a little bit but not to an extent you would in a year. I think if you knew your students and knew what they were interested in and even their learning difficulties, then I could aim the lesson at the lesson they could achieve at…. When they [students] sense the lesson too hard, they just sort of gave up a bit, so I think the strategies are important, but you also have to know your students. And you have got to target the lesson to that level so they can achieve it.*

Similarly to Paula's case, Elsa indicated that it was important to try getting to know the students during her placement. The quote by Elsa sheds light on the importance of her getting more time during her placement to perhaps get to know how students learn and teach them using strategies that will motivate them for learning science. This sentiment of getting to know the students were also echoed by Elsa's supervising teacher Lorna, who stated that Elsa's theory-in-use has been *"Definitely more consistent"* and that "*knowing your students is going to be key"* to get students motivated for learning science.

During the science lesson observations for Elsa, I noted that Elsa's theory-in-use was very consistent and did not change much. Although I observed that in her lessons, there were elements of contemporary strategies used, such as group work and experimentation, Elsa seemed to use traditional strategies, such as giving students notes very often. Notes were given for long periods during her science lessons as Elsa would write the notes on the board, wait for the students to write the notes, erase sections of notes from the chalkboard and write more notes for the students to copy in their notebooks. This theory-in-use, along with her espoused theory about giving students notes, is discussed in section 6.1.3.2. of this study.

The assertion by me that Elsa held a traditional theory of action is based on the fact that 1) Elsa espoused and justified her espoused belief for the use of traditional strategies such as giving students notes. 2) I observed that Elsa spent a lot of time writing notes on the board for the students to take down in their notebooks. The espoused belief and her theories-in-use, therefore, in conjunction with Elsa and her supervisor stating that her beliefs had not changed, aligns with the claim by Pajares (1992), who suggested that traditional beliefs held by teachers are generally difficult to change.

### 6.4.3. How Terry's Theory of Action Changed During His Professional Experience Placement

There was a small shift in Terry's theory of action, from traditional to contemporary. In Terry's final interview, he stated,

> *Before this placement, I knew that I wanted to try and bring in a large number of teaching resources into my lessons. In saying that, my lessons were not super structured with a bit of everything in them; they were maybe a theory lesson with a fun lesson, a prac [practical] lesson.*

Terry stated that throughout the placement period, his lessons became a bit more organized, and *"After the experience of the first couple weeks", he definitively changed my mindset on that [the structure of his lesson]. Terry continued to state that "I think it's changed. Although I am still heading down the same path of how I want to teach, what I want to use as resources, but I definitely think that my approach has changed."* This espoused change in Terry's theory of action was also noted by his supervising teacher Rebecca, who stated that *"I think he [Terry] is expanding a little bit, finding different ways, doing a little bit of research. He knows the kids better now."* During the science lesson observations, I conducted for Terry's lesson, I noted that Terry used more traditional methods for motivating students to learn science. For instance, in Terry's First and second science lessons that I observed, I noted that Terry gave the students notes to take down, and those classes always started with students being given their workbooks. During Terry's second interview, he justified his reason for giving students notes (discussed in Section 6.1). Although Terry's espoused theory was concluded by me as being contemporary in nature, his theories-in-use was considered as being more traditional than contemporary. This was because I observed that Terry spent more time during his lessons using traditional methods to motivate students for learning science. During Terry's final interview, I noted that he was hesitant to fully acknowledge that there was a change in his theory of action. This hesitancy by Terry was evidenced when he said that his beliefs about strategies changed "*Although I am still heading down the same path of how I want to teach."* This reluctance to fully admit that there was a complete change was not surprising because, as explained in Elsa's case, Pajares (1992) suggested that traditional beliefs are more resilient to change than contemporary beliefs.

When I asked the reason why he believed that his theory of action changed during his professional experience placement, Terry stated

> *I think that you need to get to know them, know the kids, get to know how they learn, get to know their interests, which does not take that long. Then find ways you can motivate the students through that. So, it is gaining the trust of the students is essential…also building a rapport with them.*

The identification that getting to know students was an important reason for the change in beliefs was akin to Paula's and Elsa's cases.

### 6.4.4. Summary of the Changes in the Pre-Service Teachers' Theory of Action

From the data on the pre-service teachers' change in theory of action, I noted two main points. First, the pre-service teachers in phase two of this study generally have contradicting espoused theories and theories-in-use. This finding was not surprising because education researchers (e.g. Harnett, 2012) have found that discrepancies usually exist between teachers' espoused beliefs and theories-in-use. Moreover, pioneers of the theory of action, Argyris and Schon (1974), have asserted that humans rarely have espoused theories that are congruent with their theories-in-use.

The second important finding emanating from the study pertaining to the pre-service teachers' change in theory of action was that, in all three cases of Phase Two, the pre-service teachers and their supervising teachers espoused that the pre-service teachers' theory of action changed from being traditional to more contemporary. The participants espoused that this change in theory of action was mainly due to them getting to know students and how they learn during their professional experience placement.

I treated this second finding from this phase of the study as conceptually different from all the other data gathered, especially in light of the fact that the item "*Know students and how they learn"* is the first standard listed in the Australian Professional Standards for Teachers document (Australian Institute for Teaching and School Leadership, 2011). The Australian Institute for Teaching and School Leadership (AITSL) state that this standard involves addressing six main focus areas, which suggest teachers should consider addressing those focus areas if they are to get to know students and how they learn.

The change in the pre-service teachers' theory of action as a result of getting to know students and how they learn is significant because it shows that they are aware of and are guided by the professional standards as they go through the ITE program and placement. Other education researchers have also supported the findings that getting to know students and how they learn is important. For example, Cho and DeCastro-Ambrosetti (2005) found that pre-service teachers' attitudes toward teaching students changed when they became aware of the students' diverse cultures and backgrounds.

In Chapter 7, I present the conclusions of the study as it pertains to the factors influencing pre-service teachers' theory of action about strategies for motivating students for learning science. I also present the study's significance, limitations, recommendations, and implications in Chapter 7.

# Chapter 7

# Conclusion

## Introduction

In Chapters 5 and 6, the data gathered from the web-based survey and the three individual case studies were analysed and discussed. The research findings show that the participating pre-service teachers' theory of action about strategies for motivating students to learn science was mainly contemporary. However, the data indicated that the pre-service teachers espoused some traditional beliefs and theories-in-use, especially in Phase Two. The factors influencing their theory of action have been classified into two categories: personal factors and environmental factors. Chapter 6 also presented and discussed findings pertaining to how the three pre-service teachers' theory of action from Phase Two of this study changed during their professional experience placements.

The study was designed to investigate factors influencing pre-service teachers' theory of action about strategies to motivate students for learning science at the lower secondary school level. The following research questions were addressed:

1. What are pre-service teachers' espoused beliefs about strategies for motivating students to learn science during their professional experience placement?
2. How do pre-service teachers enact their espoused beliefs for motivating students to learn science during their professional experience placement?
3. What factors influence pre-service teachers' theory of action about strategies to motivate students to learn science?
4. How do pre-service teachers' theory of action change as they progress through their professional experience placement?

In this chapter, Section 7.1 summarises the findings of the study. This involves comparing the pre-service teachers' theory of action observed in Phases One and Two. This comparison is critical as it highlights the similarities and differences in their theory of action and the factors they believed influenced their theories during their professional experience placements.

Section 7.2 discusses the significance of the findings and highlights the importance of this research in the broader science education context. Section 7.3 discusses the limitations of the study, and Section 7.4 recommends and suggests possible further research. The chapter concludes with Section 7.5, in which the implications of the findings for science teacher educators, practising science teachers, supervising teachers, tertiary academic advisors, resource and software developers, and science education curriculum developers are discussed.

## 7.1 Summary of the Findings of This Study

Chapters 5 and 6 presented the findings of Phases One and Two of this study. In Phase One, a web-based survey was used to capture the participating Australian secondary science pre-service teachers' espoused beliefs about motivating students to learn science during their professional experience placements and how those beliefs were developing. Phase Two focused on three in-depth cases to gain further insight into the pre-service teachers' theory of action about strategies for motivating students in the context of their professional experience placements and how these theories changed during the period of the study. The following Sections compare the findings from both phases and discuss the strategies and factors that influenced the participants' beliefs about motivating students for learning science.

### 7.1.1 Comparing Pre-service Teachers' Theory of Action from Phases One and Two

In both phases of the research, the participants indicated similar strategies for motivating students to learn science. Table 7.1 shows the main strategies the participants espoused and enacted for motivating students to learn science during their professional experience placement.

**Table 7.1**

*Main Strategies for Motivating Students: From Phases One and Two*

| **Four Principles of Motivation (From Turner et al., 2011)** | **Phase One Participants**<br>**Theory of Action (Espoused and Enacted theories)** | **Phase Two Participants**<br>**Theory of Action (Espoused and Enacted theories)** |
|---|---|---|
| Developing students' academic competency | Providing feedback to students<br><br>Having demonstrations of science experiments | Giving students feedback (Paula, Elsa, Terry: contemporary)<br>Hands-on practical tasks (Elsa: contemporary)<br><br>Giving students verbal cues (terry: contemporary)<br><br>Scaffolding students (Elsa: contemporary) |
| Fostering belongingness | Engaging students in collaborative/cooperative group work | Engaging students in collaborative/cooperative group work (Paula: contemporary)<br><br>~~Using games (espoused theories) (Elsa: contemporary)~~<br><br>Developing a good rapport with the students (Terry: contemporary)<br><br>Using motivational language (phrases) (Terry: contemporary) |
| Giving students' autonomy | One respondent mentioned that they would give students autonomy in the classroom by allowing students space to create their lessons. | Giving students independence (espoused belief) (Paula: contemporary)<br><br>Did not give students autonomy (theory-in-use) (Paula, Elsa and Terry) |
| Making science learning meaningful | Have discussions and conversations with students about the concepts being taught.<br><br>Making learning relevant to students. | Connecting to students-making learning relevant (Paula, Terry: contemporary)<br>Getting to know students (Paula: contemporary)<br><br>Having discussions and conversations with students about science content (Paula, Terry: contemporary)<br><br>Getting to know students' prior knowledge (Elsa, Terry: contemporary)<br>Having demonstrations and explanations of concepts (Elsa: contemporary) |

Table 7.1 shows that the Phase One and Phase Two participants held similar beliefs about strategies to motivate students for learning science. Most respondents of the web-based survey agreed that giving students autonomy was not a significant feature during their science lessons. As mentioned in Chapter 6, although two out of the three Phase Two pre-service teachers said they would give students autonomy during science lessons, I did not observe any of them doing this in their classrooms, and there was no mention of strategies to support students' autonomy in their lesson plans. Consequently, the pre-service science teachers' theory of action about strategies for motivating students to learn science is demonstrated by the similarities in both phases of this study. The main strategies they suggested were engaging students in collaborative/cooperative group work, having discussions with students, making learning relevant to students, and by giving students feedback, having demonstrations of science experiments in the classroom.

In both phases, the participants suggested that it was important to use more traditional strategies such as giving students notes to take down in their books because of its extrinsic value, that is, to help prepare (via revision of their work) students for exams. The participants justified using this traditional strategy even though they knew this strategy did not generally motivate students to learn science. For instance, 27 out of 52 respondents to the web-based survey indicated they would give students individual tasks in their workbooks to complete during science lessons. Moreover, two Phase Two participants, Elsa and Terry, justified their use of traditional strategies, such as giving students individual work to do in their workbooks and taking notes in their notebooks during their science lessons. Both Elsa and Terry said that such traditional strategies were crucial to helping their students perform better on science tests. As discussed in Section 6.1, these pre-service teacher beliefs about the use of such traditional strategies for motivating students to learn science is not a surprising finding because they have limited experience and knowledge about the strategies that can be used.

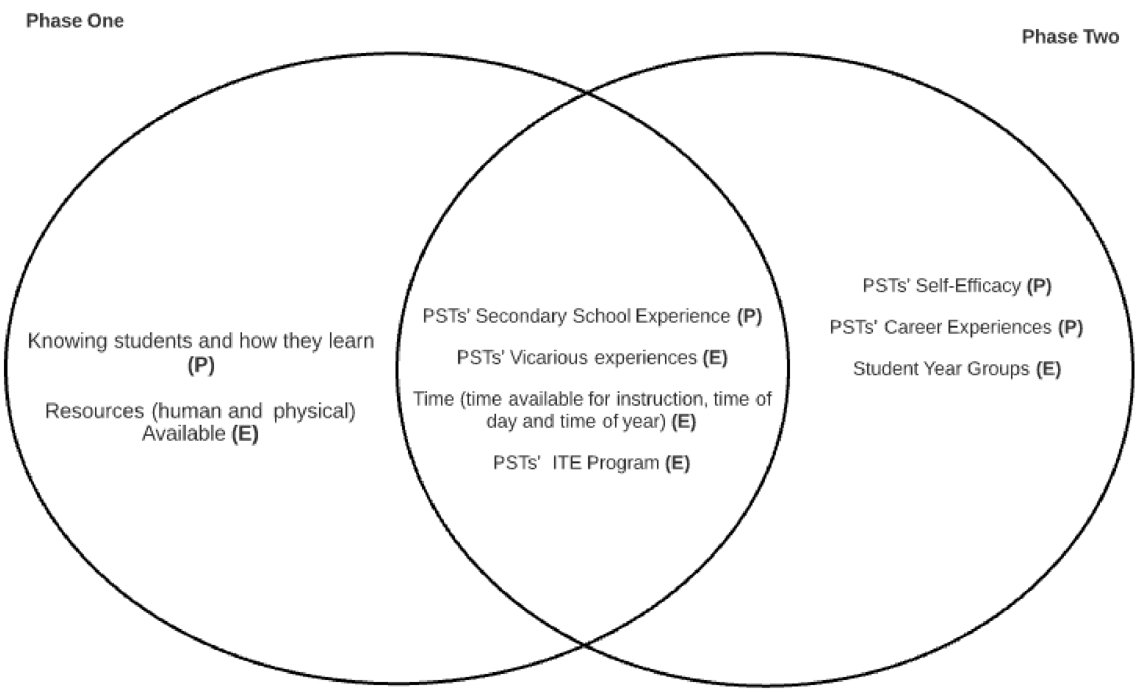
### 7.1.2 Comparing the Factors That Influenced the Pre-Service Teachers' Theory of Action

The study was designed to investigate the factors influencing pre-service teachers' theory of action about strategies for motivating students to learn science at the lower secondary school level. These factors were categorised (see Sections 5.3 and 6.2) as being personal factors and environmental factors. I found that the main personal factors were the pre-service teachers' prior secondary school learning experiences, their knowledge of students and how students learn, their self-efficacy, and their personal career experiences. The main environmental factors were time for instruction and time of year, the participants' vicarious experiences, their ITE program, student year groups and resources available for instruction. Some pre-service teachers suggested that specific factors affected their theory of action at different times during their placements.

To provide a holistic picture of the main factors influencing the pre-service teachers' theory of action, I compared the main factors from Phase One with those of Phase Two (see Figure 7.1).

**Figure 7.1**

*Main Factors Influencing the Pre-Service Teachers' Theory of Action (Phases One and Two)*




*LEGEND:*

*Personal Factors-P*

*Environmental Factors-E*

It can be seen from the central overlapping section in Figure 7.1 that the participants in both phases had similar ideas about the factors shaping their beliefs about how they motivate students to learn science. For instance, as discussed in Section 5.3, two of the leading influences were time available for science instruction and the pre-service teachers' own prior experiences of learning high school science. Participants from both phases suggested that there was never enough time to execute their science lessons, which led them to use more economical strategies such as demonstrations and giving notes. Additionally, the participants indicated that the lack of time affected their ability to give students detailed feedback on classroom tasks and conduct student-centred learning activities such as field trips and hands-on practical activities.

Another similarity between the two groups of participants is that they agreed that their vicarious learning occurred by observing their supervising teachers and other practising teachers demonstrate acceptable teaching practices at the placement schools. These supervising teachers and other practising teachers knew their students and how to teach them in ways that would motivate them to learn science, and this helped the participants develop their ideas for motivating science students (discussed in Section 5.3). This finding aligns with the social learning theories of Albert Bandura (1977), who asserted that observational learning is vital for ensuring that people learn the acceptable practices of a given social context, which in this instance was teaching.

In addition to observing these teachers, the participants reported that having conversations about strategies with other high school teachers during their professional experience placement also helped them frame their ideas about motivating students for learning science. The other major factor influencing the pre-service teacher participants' theory of action was their learning experiences in their ITE program at their current university (discussed in Section 5.3). Participants in both phases of this study indicated that their lecturers frequently demonstrated teaching strategies they could use for motivating students to learn science during their professional experience placements; for example, how to make learning relevant; how to conduct group work activities, and make learning enjoyable (as discussed in Section 5.3); and how to question students.

Although there were similarities in the factors that influenced the theory of action of the participants of the two phases of the study, there were also differences. One significant difference was that 47 out of 52 of the respondents in Phase One indicated that the strategies they used during their lessons depended on the instructional resources available at the placement school (discussed in Section 5.2). The resources they identified were human resources, such as assistance from laboratory technicians, and physical resources, such as charts and scientific apparatus. They reported that where there was a lack of resources during science lessons, they could not use as many student-centred strategies as they usually would have if more resources were present at the school. Additionally, the Phase One participants who were placed at heavily resourced schools commented that the presence of human and physical resources facilitated their use of contemporary strategies to motivate students for learning science.

Contrary to the factors espoused by the Phase One participants, the three Phase Two participants did not mention that the availability of resources at their placement schools was a factor influencing their theory of action for motivating students to learn science. However, these participants indicated that the time of day they conducted their science lessons influenced their choice of strategies (discussed in Section 6.2). This finding is supported by the work of Christophel and Gorham (1995), who found that the time of day in which a subject is taught can either motivate or demotivate college students to learn.

The Phase Two participants also mentioned that during their professional experience placements, they learned how to motivate students to learn science through trial and error. Because their 4-week placement did not allow them enough time to get to know the students, they resorted to trying various time-saving strategies to motivate their students. I noted that while some of these strategies were contemporary and student-centred, others deviated from the widely accepted social cognitive approaches that science educators recommend for motivating students to learn science.

Furthermore, when comparing the responses between the phases of the study, it was noted that two Phase Two participants reported in their interviews that as they progressed through their placements, they began to understand that it was not enough to know their students' backgrounds and the students' prior knowledge. All three mentioned that the students in the different year levels they taught responded differently to their strategies. For instance, Paula had used classroom discussion as the primary strategy with Year 9 students in her last lesson. During her interview, she indicated that discussion as a strategy worked well with that year group because they "*needed very little scaffolding*", but it "*would not work"* with her Year 8 students. There was, therefore, the assumption that Year 8 students have different cognitive levels from Year 9 students.

The pre-service teachers' beliefs and experiences influencing their choice of strategies to motivate students to learn science have been examined in personal and environmental contexts. This investigation was informed by the social cognitive notion that pre-service secondary science teachers' beliefs are shaped in the context of the social world in which they live. The participants' plans to motivate students for learning science were impacted by personal factors such as their own secondary schooling experiences and school-based factors such as gaining vicarious learning experiences from other teachers, including their supervising teachers.

## 7.2 Significance of the Findings

Pre-service teachers' beliefs about pedagogical practices in the context of motivating students to learn have been the focus of educational research for over a decade (Prestridge, 2017; Tondeur et al., 2017). What has not been widely researched is secondary science pre-service teachers' theory of action about strategies for motivating students to learn science at the lower secondary school level in the context of their professional experience placements.

The findings of this study are a valuable addition to this body of knowledge for five reasons. Firstly, they highlight the incongruency that exists between what secondary science pre-service teachers believe about motivating students for learning science at the lower secondary school level and how they enact those beliefs during their professional experience placements. This incongruency is further exacerbated by the difference between learning about pedagogical strategies that occur by the pre-service teachers during their ITE programs and how they use those strategies during their placements to motivate students for learning science. This incongruency is crucial, as it is relevant not only to science education but also to initial teacher education in general. Consequently, future research would be needed to uncover the extent to which incongruencies exists in what pre-service teachers learn during their ITE programs and how they put their knowledge into practice during their placement period.

Secondly, the findings can help secondary science pre-service teachers become aware of the critical role their beliefs play in determining the strategies they use to motivate students during their professional experience placements. This study raises the critical issue of how secondary science pre-service teachers can be made aware of how they can better align their espoused beliefs and theories-in-use to motivate students for learning science. This awareness may allow them to be more open to replacing traditionally held beliefs with accepted contemporary beliefs.

Third, despite the many contributions to research on teachers' beliefs and their enactments of those beliefs in the Australian context, there have been no comparable studies of pre-service teachers in the context of their professional experience placements. Therefore, the findings of this study should be of importance to Australian-based researchers and teacher educators because they provide critical background data for additional research on pre-service teachers' theory of action about strategies to motivate students for learning science at the lower secondary school level. The findings, therefore, highlight the importance of finding solutions for motivating students in this age group where there are well-known engagement challenges in the science classroom. This contextualisation of the findings only to the Australian context is therefore understandable because the factors that may influence pre-service teachers' theory of action espoused by Australian PSTs may be different from PSTs from other parts of the world.

Fourth, this study's findings are crucial to science education authorities in Australia because they identify how personal and environmental factors, forming part of the triadic reciprocality model of the social cognitive theory, can influence what pre-service teachers believe and subsequently how they enact their beliefs about strategies to motivate science students. Additionally, the findings identify possible strategies for secondary science pre-service teachers to adopt during their placements to motivate students for learning science. For example, one of those strategies that secondary science pre-service teachers can adopt is further supporting students' autonomy in order to enhance their motivation for learning science by allowing students to have an input in the teaching-learning process.

Fifth, this study is significant because of the use of Turner et al.'s (2011) four principles of motivation. Using Turner et al.'s (2011) principles of motivation allowed me to determine how the participating pre-service teachers' theory of action changed during their professional experience placements. Only three of these principles – competency, belongingness, and meaningfulness – were consistently used by all participants during their placements, with varying degrees of success. The pre-service teachers generally did not strongly regard giving students autonomy (the fourth principle) as important for motivating them to learn science, which implies that teacher educators should focus more on this aspect during ITE programs. Again, the findings provide important baseline data for science education researchers.

### 7.3. Limitations

This section discusses the following limitations of the study: my presence in the classroom, the time of year when data were gathered, the length of time spent in the field, and the nature of the participants of the study.

The lesson observations required my presence in the pre-service teachers' secondary science classrooms. Although intended to be unobtrusive, this may have affected the participants' beliefs and subsequently how they enacted those beliefs about strategies to motivate students for learning science during the lesson observation period. For this type of research, especially when conducting classroom observations to capture complex behaviours such as theories-in-use, it is important to have research teams (McPhail et al., 2000; Turner et al., 1998). I was the only person gathering data via classroom observations, and this limited the amount of data that he collected. This was one of the reasons I interviewed the pre-service teachers' supervising teachers, who were usually positioned to the back of the classroom for their interview near me. They provided some triangulation of the observational data.

Time constraints were also a limitation I experienced during the data-gathering stage of this study. There was a short amount of time – 4 weeks in which the three (3) pre-service teachers could conduct their professional experience placements. After allowing the first week for them to settle into their placement schools, I could observe each pre-service teacher's science lessons only once a week during each of the remaining three weeks.

Phase Two of this study, lesson observations were conducted in November and December of 2018, which in Australia is towards the end of the school year. The participants' theories-in-use and their espoused beliefs might have been affected by the fact that some students had already completed their end-of-year exams.

An additional limitation was the unusual nature of the Phase Two sample. The Phase Two sample consisted of three (3) pre-service teachers in NSW, which meant that I did not plan on generalizing the results, as previously stated in Chapter 4, to the wider pre-service teacher population.

A final limitation of this study was the examination of the environmental factors on teacher perception through the teachers' self-reports. Since this is a study on theory of action, I am not sure whether pre-service teachers are fully aware of their espoused beliefs and theories-in-use as it pertains to the environmental factors influencing their strategies for motivating students to learn science.

## 7.4 Recommendations for Future Research

I suggest four recommendations based on the data analysed for future research. The first is that there be a longitudinal study of pre-service teachers' theory of action about strategies for motivating students to learn science. That study should continue throughout their secondary science ITE programs. Various researchers (e.g., Qiu et al., 2021) have demonstrated that longitudinal studies can provide powerful evidence to highlight pre-service teachers' beliefs about strategies for motivating students to learn science at the lower secondary school level and how those beliefs change.

Secondly, considering the plethora of social factors embedded in the personal and school-based categories that influenced the pre-service teachers' theory of action, I recommend that a social cognitive theory approach be taken in future research on this topic. Such studies should include the interpersonal and intrapersonal elements pre-service teachers deal with during their professional experience placement periods. This can be achieved via a longitudinal study that should span from the time pre-service teachers enrol in their ITE program and end at the time of their completion.

The third recommendation is a methodological direction. The instrument designed for Phase One has been renamed The Pre-Service Science Teacher Theory of Action Instrument (see Appendix E) to be further developed and refined for future use by science education researchers, teacher educators and pre-service science teachers. This will assist them in gaining an understanding of the pre-service teachers' espoused beliefs before their professional experience placements, how those beliefs are enacted to become theories-in-use during their placements, and how their theory of action about strategies for motivating students to learn science continue to change after their professional experience placements.

## 7.5 Implications of the Study

The findings of this research have implications for science teacher educators, supervising teachers of pre-service teachers, tertiary academic advisors, resource and software developers, and science teacher education curriculum developers.

### 7.5.1 Implications for Science Teacher Educators

The findings from this study are promising as they point out that ITE programs can positively shape secondary science pre-service teachers' theory of action. They reveal the importance that teacher educators should place on helping pre-service teachers self-diagnose their beliefs about strategies for motivating students to learn science before and after their professional experience placements. In light of this finding, I advocate the use of the Pre-Service Science Teacher Theory of Action Instrument (see Appendix E) that he created as a tool for teacher educators. This instrument offers teacher educators insights into what pre-service science teachers believe about strategies for motivating students for learning science before they begin their professional experience placements, how they enact their beliefs during the placements, and how these beliefs might change afterwards. Furthermore, the instrument captures the factors that may influence their beliefs.

With the plethora of data that can be captured by the Pre-Service Science Teacher Theory of Action Motivation Instrument, teacher educators can plan learning experiences and lectures that will take into account the pre-service teachers' beliefs about strategies for motivating students to learn science. Gathering this data is particularly important since this study found that the participating pre-service teachers were in general agreement that their theory of action changed from traditional to more contemporary as they progressed throughout their placements.

Another critical implication for teacher educators was that while the pre-service teachers in this study espoused and enacted three of Turner et al.'s (2011) principles of motivation – competency, belongingness, and meaningfulness – it was observed that their students were not given much autonomy (the fourth principle) in the classroom. However, this study also found that environmental and personal factors may have contributed to the lack of autonomy given to students. The lack of giving students autonomy means that pre-service teachers may not be confident enough to allow students to explore the content to sufficient depth by themselves. An implication of this is that teacher educators can help pre-service teachers motivate students for learning science by introducing them to strategies that encourage student autonomy.

This study also found that two out of the three pre-service teachers who participated in the second phase of this research held steadfast beliefs about traditional didactic strategies such as note-taking and lecture-type teaching. One of the pre-service teachers was found to have a significantly stronger traditional theory of action about strategies for motivating students to learn science. This suggests the presence of environmental factors, for example, time (temporal and scheduled), and personal factors, for example, prior secondary school learning experiences, may have a negative impact on pre-service teachers' theory of action. Additionally, the occurrence of this didactic theory of action is concerning in that it highlights how pre-service teachers may lack the confidence to meaningfully engage students in inquiry learning and investigative activities related to the topic being taught.

The participating pre-service teachers' self-efficacy beliefs suggest certain gains from their formal ITE programs, as well as from their vicarious learning experiences. For example, the item "*I believe that when students get timely feedback on their assignments, they can be motivated to learn science"* indicated the possibility that the pre-service teachers were accustomed to educational experiences where they were motivated to learn science primarily through receiving feedback from their university teachers.

Contrary to the leading contemporary espoused beliefs of the pre-service teachers about strategies for motivating students to learn science, I observed that their theories-in-use were largely traditional. The most-used traditional strategy was giving students notes to take down in their workbooks. Even when more contemporary strategies such as group work, giving students feedback on their tasks, offering to scaffold students during tasks, and referencing students' prior learning were used, other factors influenced their effectiveness. The participants mentioned that their own prior secondary school learning experiences; insufficient time for planning and instruction; time of day and time of year; lack of available resources for instruction; and students' prior knowledge affected the strategies they used and how they used them to motivate students for learning science. Therefore, the implication for science teacher educators is that they should consider the aforementioned combination of factors when planning science education experiences during their ITE program courses for their pre-service teachers.

A final implication for Teacher educators is that pre-service teacher beliefs are constantly evolving, and some of the factors influencing their beliefs have changed since this study finished and will continue to change in the future. There are currently considerable changes to how education is provided to students globally. For example, because of the COVID-19 pandemic, educators have been forced to consider a more blended learning platform. This also means that pre-service teachers have had to deal with this shift in instructional modes for that pandemic period. This shift in how pre-service teachers receive instruction during their ITE and how they are expected to conduct the socially distant professional experience placements places more significant pressure on novice teachers to find strategies for motivating students to learn science. This pressure on pre-service teachers can consequently lead to more incongruence between their espoused beliefs and their theories-in-use during theory placement. This pressure on pre-service teachers can also make them feel a sense of low efficacy for motivating students to learn science.

### 7.5.2 Implications for Supervising Teachers

One of the main findings of this study is that the pre-service teachers vicariously learned about strategies for motivating students to learn science by observing their supervising teachers. An implication of this is that supervising teachers can support pre-service teachers by intentionally modelling their motivational strategies during placement classes. It must be emphasised that the main message emanating from this study is a positive one: the supervising teachers played a supportive role by modelling strategies that can motivate students for learning and directing the pre-service teachers to practising teachers at the placements school. The scaffolding that supervising teachers provide to pre-service teachers can make pre-service teachers feel more confident to explore their beliefs about strategies about how to motivate students for learning science.

Furthermore, since the supervising teachers and other teachers at the placement schools were instrumental in providing vicarious learning experiences to the pre-service teachers, I recommend that this practice of supporting pre-service teachers' vicarious learning should continue. This support will encourage pre-service teachers to learn vicariously and partake in best practices that they observe teachers use during their placement. In addition, supervising teachers should be encouraged to give scaffolding and quality, timely feedback to support and optimise pre-service teachers' motivation strategies during their professional experience placements. In essence, supervising teachers and other teachers at placement schools should continue supporting pre-service teachers to develop their theory of action.

### 7.5.3. Implications for Academic Tertiary Advisors

Another implication of this study is that during their professional experience placements, pre-service teachers' theory of action can be further supported by advice from their assigned academic tertiary advisors on the best strategies for motivating particular student groups for learning science. Moreover, tertiary academic advisors can encourage pre-service teachers to engage in reflective practices to continue forming and shaping their theory of action during their professional experience placements.

### 7.5.4. Implications for Resource and Software Developers

This study identified that the available instructional resources also influenced the pre-service teachers' theory of action about strategies for motivating students for learning science. An implication of this is that school leaders such as heads of Science Departments should ensure that pre-service teachers have access to quality science resources such as charts and models during their professional experience placements. This will allow pre-service teachers to become more confident in using contemporary strategies for motivating their students.

### 7.5.5. Implications for Initial Teacher Education Curriculum Developers

The degree of incongruence between what the pre-service teachers said they did (their espoused theories) and what they actually did (their theories-in-use) to motivate students for learning science was noticeable throughout the research. This is a significant finding that underscores the importance of examining how secondary science pre-service teachers motivate students during their professional experience placement in relation to the factors (personal and environmental factors) discussed in Sections 5.3 and 6.2. A key implication of this is that ITE curriculum developers should increase their focus on the personal and environmental factors influencing pre-service teachers' beliefs about and strategies for motivating students to learn science at the lower secondary school level. By considering those factors, ITE curriculum developers can better tailor secondary science programs to pre-service teachers.

### 7.5.6. Theoretical Implications

This study has implications for the following three theories:

i. Motivation Theory
ii. Theory of Action
iii. Social Cognitive Theory

Motivation Theory

This research involved the four principles of Motivation: Competency, Belongness, Autonomy and meaningfulness. While the findings showed that the pre-service teachers espoused and enacted various examples of how they can motivate students for learning science using Competency, Belongingness and Meaningfulness, it was observed that students were not given much autonomy in the classroom. This suggests that the principle of motivation: Autonomy may require further attention from science curriculum developers of teacher education. However, this research study also showed that there might also be school-based as well as personal factors that may have contributed to the lack of autonomy given to students in the classroom. The implication of this is that pre-service teachers are not confident enough to allow students to explore the content to sufficient depth by themselves.

Theory of Action

Pre-service teachers' high self-efficacy beliefs suggest certain gains in their formal learning experiences, e.g., their ITE programs, as well as their vicarious learning experiences. For example, for the item: I believe that when students get timely feedback on their assignments, they can be motivated to learn science; this indicates the possibility that pre-service teachers were accustomed to educational experiences where they received and were motivated to learn science primarily through receiving feedback from their teachers. The high positive teachers' self-efficacy is probably also expected because of the perceived background in science that the pre-service teachers are expected to have before enrolling into the secondary science initial teacher education program.

Contrary to the main contemporary espoused beliefs of the teachers about strategies for motivating students to learn science, during the lesson observation phase of the study, the researcher observed that the pre-service teachers' theory-in-use as being largely traditional in nature. The most used traditional strategy that the researcher observed used by the pre-service teachers was giving students notes to take down in their workbooks.  Even when more contemporary based strategies such as group work, giving students feedback on their tasks, offering to scaffold students during tasks, peer evaluation, and referencing students' prior learning, were used to motivate students for learning, various factors influenced the extent to which those strategies could be used effectively. Most of the pre-service teachers suggested that factors such as prior secondary school learning experiences, not enough time for planning and instruction, time of the year, resources available for instruction, students learning styles, time of day and classroom management influenced what strategies they used and how they used the strategies to motivate students for learning science.

The degree of incongruence in what pre-service teachers say they do; their espoused theory and what they actually do; theory-in-use, to motivate students for learning science concerning. This is a very significant finding that underscores the importance of examining how secondary science pre-service teachers motivate students during their professional experience placement in relation to the aforementioned factors. A key implication of this is the requirement for the development and implementation of a secondary science education curriculum with an increased focus on the factors influencing pre-service teachers' beliefs about and strategies for motivating students to learn science at the lower secondary school level.

### Social Cognitive Theory

The results of this study indicated that some pre-service teachers hold steadfast didactic or traditional beliefs about strategies for teaching students. During the data gathering process, I observed that those traditional beliefs translated to a traditional approach to teaching students that involved taking down notes and lecture-type teaching. This seems to be the case amongst two out of three pre-service teachers who participated in the second phase of this research. However, it was notable that the pre-service teacher who taught at the rural school was found to have a significantly stronger traditional theory of action about strategies for motivating students to learn science. This may have suggested the presence of environmental factors, for, e.g., Student behaviours, and personal factors, e.g., prior learning experiences, that may have a negative impact on the pre-service teachers' theory of action. The implications of the environmental factors influencing the pre-service teachers' theory of action need to be further investigated on a deeper level. Additionally, this didactic theory of action is concerning in that it may highlight the pre-service teachers' lack of confidence in meaningfully engaging students in motivational pedagogical strategies related to the topic being taught.

## 7.6. Conclusion

This study examined the factors influencing pre-service teachers' theory of action, which comprised of their espoused theories and theory theories-in-use, about strategies for motivating students to learn science. This study involved a two-phase approach, with participants being Australia wide in Phase one and three participants from regional NSW in Phase Two. In this study, I unmasked the incongruency that exists in the pre-service teachers' theory of action about strategies for motivating students for learning science at the lower secondary school level; that is, between what secondary science pre-service teachers believe (espoused theories) and how they enact (theories-in-use) those beliefs during their professional experience placement. This incongruency stemmed from personal and environmental factors, with the pre-service teachers' theory of action being categorised generally as contemporary approaches concerning motivating students to learn science, despite some pre-service teachers' theory of action deviating from widely accepted contemporary approaches to teaching science. Therefore, this study is significant as it helps provide clear future direction on how pre-service teachers can motivate students for learning science. This future direction is important to provide hope of addressing the known problem of students lacking motivation for learning science at the lower secondary school level.

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# Appendices

## Appendix A

Email to the Science Education Subject Course Coordinator

Hi Sir/Madamme,

My name is Davis Jean-Baptiste, a Ph D student at The University of Technology Sydney (UTS). I am currently conducting a study titled "How are preservice teachers developing their beliefs and strategies for motivating science students at the lower secondary school level?" As part of the study, it is my intention to conduct a case study with pre-service teachers to find out what strategies that secondary science pre-service teachers are using to motivate science students at the lower secondary level during their professional experience placement.

I am hereby requesting permission to access your class in order to recruit secondary science pre-service teachers who may be willing to volunteer. I am willing to access your class at a time and day that is convenient to you and your students.

I have included my UTS ethical clearance, and the link to my survey in this email. Thanking you in advance for your kind assistance

## Appendix B

Participant Information Sheet: Pre-Service Teachers

**How are Pre-service Science Teachers Developing their Espoused Theories and Theories- In-Use to Motivate Lower Secondary Science Students?**

**THE UTS HREC APPROVAL NUMBER: ETH18-2601**

### WHO IS DOING THE RESEARCH?

My name is Davis Jean-Baptiste and I am a doctoral student at UTS. My research supervisor Dr. Kimberley Pressick-Kilborn. Her contact details are; Phone: +61 2 9514 5330 and Email Kimberley.Pressick- Kilborn@uts.edu.au

### WHAT IS THIS RESEARCH ABOUT?

This research is to find out about how pre-service science teachers are developing their beliefs/perceptions and theories-in-use to motivate lower secondary science students. Espoused theory is defined as those micro theories/beliefs/perceptions that a person holds about how they will perform a particular task. Theory-in-use refers to an individual's behaviour or action in a given situation.

### WHY HAVE I BEEN ASKED?

You have been invited to participate in this study because;

You are a secondary science pre-service teacher completing a postgraduate or undergraduate initial teacher education degree in Secondary Science at an Australian University.

## IF I SAY YES, WHAT WILL IT INVOLVE?

If you decide to participate, I will invite you to:

- A 45-60-minute individual interview will be conducted before you conduct your professional experience placements, at the middle and at the end of your professional experience placement.
- Three lesson observations; One 40-80-minute science class per week your convenience will be observed for the duration of your professional experience placement. During the lesson observations, I will also be taking field notes.

## ARE THERE ANY RISKS/INCONVENIENCE?

Yes, there are some risks/inconveniences. They are:

- *Informed consent: You will be using a consent form that details the purpose of the study, the extent of your involvement and the consent form will highlight your right to withdraw at any time from this study.*
- *Study explanation: You will be provided with an information sheet about the study that outlines information details to each participant before the study starts, can clarify and explain the important information. This includes the information that you will not be personally evaluated, your professional learning will not be judged, and the students in-class engagement and learning will not be appraised.*
- *De-identified Data: Any data gathered from the study will be anonymous and confidential. Only the researcher will have access to the identity of the participants for the interviews and classroom observations and all data will be kept in a secure location that is password protected.*

- *Safe place for interviews: Interviews will be conducted in school spaces such as in a quiet room in the school the library. The space will be selected at a time that is convenient to you in order to ensure you are safe, non-threatening and you feel free to discuss confidentiality without judgement or disclosure. Moreover, while it is hopeful that the interviews will occur in a quiet place in the school's library for instance, the interviews will ultimately be held at a time and mode (include Skype audio or telephone) and place that is convenient to you.*
- *Reminders: I will constantly remind you that there will be no reporting on your participation in the study to your tertiary advisors and that all communication as well as observations will be confidential and safeguard. I will also remind you that this study is not an evaluation of your work, teaching or your students' learning.*

## DO I HAVE TO SAY YES?

Participation in this study is voluntary. It is completely up to you whether or not you decide to take part.

## WHAT WILL HAPPEN IF I SAY NO?

If you decide not to participate, it will not affect your relationship with the researchers or the University of Technology Sydney. If you wish to withdraw from the study once it has started, you can do so at any time without having to give a reason, by contacting me at Davis.L.JnBaptiste@student.uts.edu.au or phone +61 [redacted].

Additionally, you can contact my research supervisor on phone: +61 2 9514 5330 and email Kimberley.Pressick- Kilborn@uts.edu.au.

If you withdraw from the study, your transcripts will be destroyed, and the audio recordings erased.

## CONFIDENTIALITY

By signing the consent form, you consent to me collecting and using personal information about you for the research project. All this information will be treated confidentially. I assure you that your confidentiality will be maintained as observation data will not be discussed with anyone. Additionally, your name or anything that can identify you or the school where you will be conducting your professional experience placement will not be placed on any coding sheets/records or published in any way.

I plan to publish the results in a journal that is still to be decided on. In any publication, information will be provided in such a way that you cannot be identified.

## WHAT IF I HAVE CONCERNS OR A COMPLAINT?

If you have concerns about the research that you think I can help you with, please feel free to contact me on *Phone:+61* *and email* Davis.L.JnBaptiste@student.uts.edu.au You will be given a copy of this form to keep.

**NOTE:**

This study has been approved by the University of Technology Sydney Human Research Ethics Committee [UTS HREC]. If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat on ph.: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au] and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

CONSENT FORM

How are Pre-service Science Teachers Developing their Espoused Theories and Theories- In-Use to Motivate Lower Secondary Science Students

**UTS HREC APPROVAL NUMBER:** ETH18-2601

I__________________[participant's name] agree to participate in the research project about **how pre-service science teachers are developing their beliefs and strategies to motivate lower secondary science students** [the UTS HREC approval ETH18-2601] being conducted by Davis Jean-Baptiste and Kimberley Pressick-Kilborn, at address 15 Broadway Ultimo NSW 2007 and Tel; +61 2 9514 5330/ +61 .

I have read the Participant Information Sheet, or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research as described in the Participant Information Sheet. I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time without affecting my relationship with the researchers or the University of Technology Sydney.

I understand that I will be given a signed copy of this document to keep. I agree to be:

☐ Audio recorded during an interview

☐ Have field notes taken during the lesson observation

I agree that the research data gathered from this project may be published in a form that:

☐ Does not identify me in any way.

I am aware that I can contact Davis Jean-Baptiste and Kimberley Pressick- Kilborn if I have any concerns about the research.

____/____/____

________________________________________

Name and Signature [participant] Date

____/____/____

________________________________________

Name and Signature [researcher or delegate] Date

____/____/____

________________________________________

## Appendix C

Letter For the Principal

**How are Pre-service Science Teachers Developing their Espoused Theories and Theories-In-Use to Motivate Lower Secondary Science Students?**

Ethics Approval Number: ETH18-2601

### WHO IS DOING THE RESEARCH?

My name is Davis Jean-Baptiste, and I am a doctoral student at University of Technology Sydney (UTS). My research supervisor is Dr. Kimberley Pressick-Kilborn. Her contact details are; Phone: +61 2 9514 5330 and Email Kimberley.Pressick-Kilborn@uts.edu.au.

### WHAT IS THIS RESEARCH ABOUT?

This research is to find out about how final year pre-service science teachers are developing their beliefs/perceptions and theories-in-use to motivate lower secondary science students?
Espoused theory is defined as those micro theories/beliefs/ that persons hold about how they will perform at a particular task.
Theory-in-use refers to an individual's behaviour or action in a given situation.

This study resonates with the Chief scientist whose goal is to achieve a high-level scientific literacy in the population by the year 2023. I am genuinely interested in understanding how final year pre-service secondary science teachers are developing their beliefs/perceptions about science student motivation at the lower secondary school level and how they practice those beliefs during their professional experience placements. The data collection will be during October 14th to November 15th, 2019.

## WHY HAVE I BEEN INFORMED

It is my intention to gather data with the pre-service teacher(s) who are conducting their professional placement at your school. I will be conducting regular, once a week at least, lesson observation with the Secondary Science pre- service teacher, and semi structured interviews for the final year Secondary Science pre-service teacher as well as their cooperating teachers. There will be minimal or no disturbance to school routines. Please be aware that this research only involves the Secondary Science preservice teachers and their cooperating teachers. I am hereby requesting your permission to;

- Conduct my research in your school
- Contact the cooperating teachers of the secondary science pre-service teachers to solicit their participation in the study.

Thanking you in advance for a favourable response. My SERAP approval number is: **2019197**

CONFIDENTIALITY

All this information will be treated confidentially. In this research, I will assure that you that confidentiality and anonymity will be maintained as observation data will not be discussed with anyone. Additionally, anything that can identify the school where the research will be undertaken will not be or published in any way.

WHAT IF I HAVE CONCERNS OR A COMPLAINT?

If you have concerns about the research that you think I can help you with, please feel free to contact me on Phone:

+61 [redacted] and email **davis.l.jnbaptiste@student.uts.edu.au.** Additionally, you can contact my research supervisor on phone: +61 2 9514 5330 and email Kimberley.Pressick-Kilborn@uts.edu.au.

You will be given a copy of this form to keep.

**NOTE:**

This study has been approved by the University of Technology Sydney Human Research Ethics Committee [UTS HREC]. If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat on ph.: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au] and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome

## Appendix D

Participant Information Sheet: Supervising Teachers

How are Pre-service Science Teachers Developing their Espoused Theories and Theories- In-Use to Motivate Lower Secondary Science Students?

*AND UTS HREC APPROVAL NUMBER- ETH18-2601*

### WHO IS DOING THE RESEARCH?

My name is Davis Jean-Baptiste and I am a doctoral student at UTS. My research supervisor is Dr. Kimberley Pressick-Kilborn. Her contact details are: Phone: +61 2 9514 5330 and Email Kimberley.Pressick- Kilborn@uts.edu.au

### WHAT IS THIS RESEARCH ABOUT?

This research is to find out about how pre-service science teachers are developing their beliefs/perceptions and strategies to motivating lower secondary science students to learn science.

Espoused theory is defined as beliefs/ perceptions that people hold about how they will perform at a particular task. Theory-in-use refers to an individual's behaviour or action in a given situation.

### WHY HAVE I BEEN ASKED?

You have been invited to participate in this study because

> You are a supervising teacher for a secondary science pre-service teacher who will be conducting their professional experience placement under your guidance.

### IF I SAY YES, WHAT WILL IT INVOLVE?

If you decide to participate, I will invite you to participate in;

- One 40-60-minute interview which will be centred around your experiences of supporting the pre-service teachers during their professional experience placement. The interview will be audio recorded and transcribed. I will provide you with a copy of the transcript to check and verify that the interview was transcribed accurately.

## ARE THERE ANY RISKS/INCONVENIENCE?

Yes, there are some minor risks/inconveniences.

- You will be asked some questions about how you think the secondary science pre-service teachers are developing their strategies to motivate science students. As such, you may feel worried during the interviews because of concern about disclosing information that you feel may affect your employment or collegial relationships.
- You may experience inconvenience because you will be taking time some of your time to participate in the interview.

### DO I HAVE TO SAY YES?

Participation in this study is voluntary. It is completely up to you whether or not you decide to take part.

### WHAT WILL HAPPEN IF I SAY NO?

If you decide not to participate, it will not affect your relationship with the researchers or the University of Technology Sydney. If you wish to withdraw from the study once it has started, you can do so at any time without having to give a reason, by contacting me at Davis.L.JnBaptiste@student.uts.edu.au or phone +61 [redacted].

If you withdraw from the study, your transcripts will be destroyed, and the audio recordings erased.

### CONFIDENTIALITY

By signing the consent form, you consent to me collecting and using personal information about you for the research project. All this information will be treated confidentially. I assure you that your confidentiality will be maintained as observation data will not be discussed with anyone. Additionally, your name or anything that can identify you or the school where you are working will not be placed on any coding sheets/records or published in any way.

I plan to publish the results in a journal that is still to be decided on. In any publication, information will be provided in such a way that you cannot be identified.

### WHAT IF I HAVE CONCERNS OR A COMPLAINT?

If you have concerns about the research that you think I can help you with, please feel free to contact me on Phone:

+61 [redacted] and email Davis.L.JnBaptiste@student.uts.edu.au. Additionally, you can contact my research supervisor on phone: +61 2 9514 5330 and email Kimberley.Pressick-Kilborn@uts.edu.au.

You will be given a copy of this form to keep.

**NOTE:**

This study has been approved by the University of Technology Sydney Human Research Ethics Committee [UTS HREC]. If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat on ph.: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au] and quote the UTS HREC reference number- ETH18-2601. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome

CONSENT FORM

**How are Pre-service Science Teachers Developing their Espoused Theories and Theories- In-Use to Motivate Lower Secondary Science Students AND UTS HREC APPROVAL NUMBER** *(ETH18-2601)*

I_________________*[participant's name]* agree to participate in the research project about **how pre-service science teachers are developing their espoused theories and theories-in-use to motivate lower secondary science students** *[UTS HREC approval reference number ETH18-2601]* being conducted by Davis Jean-Baptiste and Kimberley Pressick-Kilborn, at address 15 Broadway Ultimo NSW 2007 and Tel; +61 2 9514 5330/ +61 [redacted].

I have read the Participant Information Sheet, or someone has read it to me in a language that I understand.

I understand the purposes, procedures and risks of the research as described in the Participant Information Sheet. I have had an opportunity to ask questions and I am satisfied with the answers I have received.

I freely agree to participate in this research project as described and understand that I am free to withdraw at any time without affecting my relationship with the researchers or the University of Technology Sydney.

I understand that I will be given a signed copy of this document to keep. I agree to be:

☐ Audio recorded during the interview

I agree that the research data gathered from this project may be published in a form that:

☐ Does not identify me in any way unless I agree to have the results of the study sent to me (in that case confidentiality and anonymity will be assured as addressed in page 2)

I am aware that I can contact *Davis Jean-Baptiste and Kimberley Pressick-Kilborn* if I have any concerns about the research.

_______________________________________ ____/____/____

Name and Signature [participant] Date

_______________________________________ ____/____/____

Name and Signature [researcher or delegate] Date

_______________________________________ ____/____/____

Name and Signature [witness*]. Date

## Appendix E

Pre-service Science Teacher Theory of Action Motivation Instrument (Web-Based Survey)
Renamed: **The Pre-Service Science Teacher Theory of Action Instrument**

Welcome and thank you. My name is Davis Jean-Baptiste, and I am currently a Ph. D student at University of Technology Sydney (UTS). This survey is for all secondary science pre-service undergraduate and postgraduate secondary teachers. The purpose of this online survey is to find out how your beliefs about student motivation in science at the lower secondary level are developing. I am also interested in the strategies that you have used to motivate science students during your professional experience placement.

In this online survey I will ask you to answer questions and at times ask for comments, if you wish to give them. You can change your mind at any time and stop completing the survey without consequences. The survey should take about 10-15 minutes to complete.

This survey DOES NOT IDENTIFY YOU in any way and IP addresses ARE NOT collected from responses. If you have concerns about the research that you think either I or my supervisor can help you with, please feel free to contact me at davis.l.jnbaptiste@student.uts.edu.au or my supervisor, Dr. Kimberley Pressick-Kilborn, at Kimberley.Pressick-Kilborn@uts.edu.au.

If you would like to talk to someone who is not connected with the research, you can contact the UTS Research Ethics Officer on 02 9514 9772 or Research.ethics@uts.edu.au and quote this reference ETH18-2601

**Link to survey:** https://www.surveymonkey.com/r/HYTDHB2

**Section 1: Just a few details about you as a secondary science pre-service teacher. These details will not be used to identify your response in any way.**

1. I am completing
    - A postgraduate initial teacher education degree in Secondary Science at an Australian university.
    - An undergraduate initial teacher education degree in Secondary Science at an Australian university.
2. I am not completing a postgraduate or undergraduate initial teacher education degree in Secondary Science at an Australian University.
3. I have
    - Finished some of my professional experience placements and I have some more to do.

**Section 2: My beliefs about how I can motivate science students.**

4. In this Section I am interested in understanding the extent to which you believe that you can motivate science students at the lower secondary school level when you become full-fledged teachers.

| | | Strongly Agree | Agree | Undecided | Disagree | Strongly Disagree |
|---|---|---|---|---|---|---|
| *I.* | *I believe that I know how science students can be motivated to learn science.* | | | | | |
| *II.* | *I believe that I know how to facilitate students learning of science concepts in a way to that will motivate them.* | | | | | |
| *III.* | *I believe that when I provide personalized feedback on students' assessments, they will* | | | | | |

| | |
|---|---|
| | *be motivated to learn science.* |
| *IV.* | *I believe that I can motivate science students after seeking and applying constructive feedback from my supervisors on ways to improve my science teaching practices.* |
| *V.* | *I believe that I can motivate science students after seeking and applying constructive feedback from other teachers on ways to improve my* |

| | |
|---|---|
| | *science teaching practices.* |
| *VI.* | *I believe that when I use guided inquiry learning, science students can become motivated to learn.* |

**Section 3: Strategies for motivating science students at the lower secondary school level.**

**In this Section I am interested in the strategies you have used on your professional experience placements to motivate science students at the lower secondary school level.**

*5a. What teaching and learning strategies have you used to motivate science students during your professional experience placements? (Please specify)*

________________________________________

________________________________________

*5b. Can you choose one strategy that you provided in question 3a and describe the lesson/context in which you successfully used that strategy?*

*Grade:* __________________

*Topic:* ________________

*Time of day: Morning*____________*Afternoon*__________

*Resources available:* ________________________

*How was the strategy used?*

________________________________________________________________________

________________________________________________________________________

*Can you describe what you believe made the lesson a successful one?*

---

---

*6. How often have you used the following with students/ in your lessons during your professional experience placements?*

| | ***Item*** | ***Never*** | ***Occasionally*** | ***Sometimes*** | ***Often*** | **Most of the time** |
|---|---|---|---|---|---|---|
| *I.* | *I related the science concepts to real life.* | | | | | |
| *II.* | *Students worked collaboratively to plan and investigate questions, hypotheses or problems.* | | | | | |
| *III.* | *Students had time to reflect on their own performance on assessment tasks.* | | | | | |

| | |
|---|---|
| *IV.* | *Students had time to ask inquiry questions to the teachers and each other about science concepts.* |
| *V.* | *Students participated in problem solving activities in the classroom.* |

| | | | | | | |
|---|---|---|---|---|---|---|
| *VI.* | *Students engaged in guided inquiry activities.* | | | | | |
| *VII.* | *Students had time to communicate their ideas and findings of science investigations with each other.* | | | | | |

*7. How often have you used the following teaching strategies to motivate science students during your professional experience placements?*

| | ***Item*** | ***Never*** | ***Not Often*** | ***Often*** | ***Very Often*** | **Most of the time** |
|---|---|---|---|---|---|---|
| *I.* | *Placing science students in groups to work on science concepts.* | | | | | |
| *II.* | *Giving students* | | | | | |

*Individual tasks to complete.*

III. *Using classroom demonstrations to help students*

| | |
|---|---|
| | *understand science concepts.* |
| *IV.* | *Giving students the opportunity to conduct experiments.* |
| *V.* | *Giving students timely feedback on their assignments.* |
| *VI.* | *Giving science students lots of examples and non-examples of science concepts.* |
| *VII.* | *Allow science students the opportunity to conduct fieldwork.* |

*8a. For any strategy you have used in the previous question, can you give me an example of a time when you found that strategy to be effective in motivating science students to learn during your professional experience placements? (Please specify)*

______________________________________________

______________________________________________

*8b. Can you tell me why you believe the strategy was effective at that time?*

*9a. For any given strategy you have identified in the previous question, can you give me an example of a time when you found those strategies* ***NOT*** *to be effective for motivating science students to learn during your professional experience placements? (Please specify)*

*9b. Can you tell me why you think the strategy was* ***NOT*** *effective?*

**Section 4: Factors that may influence your beliefs about student motivation.**

**In this Section I am interested in any factor(s) that may have influenced the development of your own beliefs about motivation and the strategies to motivate science students to learn during your professional experience placements.**

*10a. Which of the following factor(s) have influenced the strategies you have used to motivate science students to learn? (Tick all that apply)*

I. My own experiences as a secondary school student.

II. Social Media.

III. My university ITE program lecturers.

IV. My co-operating teacher and other teachers at the school where I conducted my professional experience placement.

V. From observing other teachers teach in other subject areas.

VI. Total amount of time available for the science lesson.

VII. Time available for preparation of the science lesson during the day.

VIII. Advice from other teachers.

IX. Availability of resources for the science lesson.

X. Support from Laboratory Technicians at the school.

Other (Please explain)

_______________________________________________

_______________________________________________

*10b. Can you give me an example to illustrate how one or more of the factors in question 10a influenced the strategies you used to motivate science students to learn?*

_______________________________________________

_______________________________________________

*11. Can you share some advice for other pre-service teachers preparing to teach lower* *secondary science? What can pre-service teachers do to motivate science students to learn at the lower secondary level?*

______________________________________________________________________

______________________________________________________________________

Thank you for your time and thoughts.

**Your participation in this research is greatly appreciated. If you have any questions about the research, please contact me at davis.l.jnbaptiste@student.uts.edu.au, or my supervisor Dr. Kimberley Pressick-Kilborn at Kimberley.Pressick-Kilborn @uts.edu.au.**

# Appendix F

Pre-Service Teacher Semi-Structured Interviews

Duration: 45 minutes -1hr

Interview One of PSTs before their professional experience placements.

**Goal: To find out about the pre-service teacher espouse theories about student motivation.**

*Theme One: How are espoused theories and theories -in-use of motivation are developing during their professional experience placements? (Main Research Question, RQ1, RQ4)*

1. Can you tell me about your experiences that led you to develop your own ideas about motivating your science students?
2. Are there any other experiences that helped you develop your ideas for motivating science students? Can you explain that?
3. Have you experienced anything during your time at university that has led you to understanding how to motivate science students? Can you explain that?

*Theme Two: Factors influencing how espoused theories are enacted during the professional experience placements (RQ1, RQ2, RQ3, RQ4)*

1. How do you think you will motivate science students when you go out on your professional experience placement?
2. How effective do you think those strategies will be? Why do you say that?
3. Was there anything that influenced why you chose those particular strategies to motivate science students? (Can you explain that?)

4. How do you think being on your professional experience placement will help you develop your ideas for how to motivate science students?
5. In your current ITE program, what have you noted can help you motivate science students?

**Duration: 45 minutes -1hr**

**Interview Two of PST during their professional experience placements**

Goal: To find out how they are enacting their espoused theories of motivation (RQ1, RQ2. RQ3, RQ4)

1. Can you tell me about a science lesson when you felt that you really motivated the students?
2. What main strategies have you been using to motivate science students?
3. On a scale of 1-10 with 10 being the highest rating, how would you rate the strategies you have mentioned? Why would you give that score?
4. Are the motivation strategies you are using now different from the ideas you perceived before our professional experience placement? Can you explain that?
5. Which motivation strategy do you think has been the most effective in motivating science students? (can you explain that?)
6. How has the guidance from you cooperating teacher and science education subject educators helped you in motivating science students?

Duration: 45 minutes -1hr

Interview Three of PSTs After their professional experience placements

Goal: To find out whether the pre-service teachers' perceptions about student motivation before their professional experience placements changed during their professional experience placements (RQ1, RQ2, Main research question)

1. Can you tell me about a lesson during your professional experience placement when you believed the science students were very motivated? How do you know they were motivated?
2. How has being on your professional experience placement helped you understand how to motivate science students?
3. How did your initial beliefs about motivating science students compare with your motivational beliefs during and after your professional experience placements?
4. Which motivation strategy did you think was the most effective in motivating science students during your professional experience placements? Can you explain what made it effective?
5. Is there any time during your professional experience placements when you felt justified in using your motivational strategies? (can you explain that experience?)

# Appendix G

Supervising Teacher's Interview

**How are Preservice Science Teachers Developing their Espoused Theories and Theories-In- Use to Motivate Lower Secondary Science Students?**

Interview Questions

1. How do you believe the professional experience placements can impact the secondary science preservice teachers' beliefs about motivation?
2. How do you believe professional experience placements can impact the secondary science preservice teachers' beliefs about motivating science students?
3. How do you think the initial teaching education program support the secondary science preservice teachers to develop their beliefs about student motivation?
4. Are there any factors that you think has influenced the development of the secondary science preservice teachers' beliefs about science student motivation? If yes, can you explain?
5. What successful strategies have you noticed the secondary science preservice teacher used to motivate science students during their professional experience placement? Can you choose one strategy and tell me how was this strategy used? What made it successful?
6. What unsuccessful strategies have you noticed the secondary science preservice teacher used to motivate science students during their professional experience placement? Can you choose one strategy and tell me how was this strategy used? What made it unsuccessful?

7. Is there any advice you would give to other secondary science pre-service teachers who are conducting their professional experience placement?

# Appendix H

Information Sheet for Parents/Guardians

How are Preservice Science Teachers Developing their Espoused Theories and Theories-In-Use to Motivate Lower Secondary Science Students?
*AND UTS HREC* Number: ETH18-2601.

## WHO IS DOING THE RESEARCH?

My name is *Davis Jean-Baptiste* and I am a doctoral student at University of Technology Sydney (UTS). My supervisor is *Dr. Kimberley Pressick-Kilborn. Her contact details are; Phone: +61 2 9514 5330 and Email Kimberley.Pressick-Kilborn@uts.edu.au*

## WHAT IS THIS RESEARCH ABOUT?

This research is to find out about how final year preservice science teachers are developing their beliefs/perceptions and theories-in-use to motivate lower secondary science students?

Espoused theory is defined as those micro theories/beliefs/ that persons hold about how they will perform at a particular task.

Theories-in-use refers to an individuals' behaviour or action in a given situation.

This study resonates with the Chief scientist whose goal is to achieve a high-level scientific literacy in the population by the year 2023. I am genuinely interested in understanding how final year preservice secondary science teachers are developing their beliefs/perceptions about science student motivation at the lower secondary school level and how they practice those beliefs during their professional experience placements. The data collection will commence from October 14th to December 3rd, 2019.

## WHY HAVE I BEEN INFORMED

I will be conducting research at the school where you child is currently attending. I will be conducting lesson observation with the final year Secondary Science pre-service teacher, and semi structured interviews for the final year Secondary Science preservice teacher as well as their supervising teachers. There will be minimal or no disturbance to school routines. Please be aware that this research only involves the final year Secondary Science preservice teachers and their supervising teachers and as such your child will not be a participant in the data gathering process.

## ARE THERE ANY RISKS/INCONVENIENCE?

Yes, there are some risks/inconvenience. They are:

**For your child:**

- Your child will see the researcher in the classroom during the classroom lesson observation periods.

## CONFIDENTIALITY

All this information will be treated confidentially. I will assure that your Childs' confidentiality and anonymity will be maintained as observation data will not be discussed with anyone. Additionally, your child's name or anything that can identify the school where the research will be undertaken will not be or published in any way.

## WHAT IF I HAVE CONCERNS OR A COMPLAINT?

If you have concerns about the research that you think I can help you with, please feel free to contact me on *Phone: +61* *and email* *@student.uts.edu.au*

You will be given a copy of this form to keep.

**NOTE:**

This study has been approved by the University of Technology Sydney Human Research Ethics Committee [UTS HREC]. If you have any concerns or complaints about any aspect of the conduct of this research, please contact the Ethics Secretariat on ph.: +61 2 9514 2478 or email: Research.Ethics@uts.edu.au], and quote the UTS HREC reference number. Any matter raised will be treated confidentially, investigated and you will be informed of the outcome.

# Appendix I

Ethics Approval from UTS

Dear Applicant,

Thank you for your response to the Committee’s comments for your project titled, "*How are Pre-Service Science Teachers Developing their Espoused Theories and Theories-In-Use to Motivate Lower Secondary Science Students?"*. The Committee agreed that this application now meets the requirements of the National Statement on Ethical Conduct in Human Research (2007) and has been approved on that basis. You are therefore authorised to commence activities as outlined in your application.

You are reminded that this letter constitutes ethics approval only. This research project must also be undertaken in accordance with all UTS policies and guidelines including the Research Management Policy (http://www.gsu.uts.edu.au/policies/research-management-policy.html).

Your approval number is UTS HREC REF NO. ETH18-2601.

Approval will be for a period of five (5) years from the date of this correspondence subject to the submission of annual progress reports.

The following special conditions apply to your approval:

• Upon receiving SERAP approval, the researcher will write to the school principals for permission to conduct research at the schools where the secondary science PSTs will be conducting their professional experience placement. After this has been done, the researcher will provide evidence of consent to UTS HREC.

The following standard conditions apply to your approval:

• Your approval number must be included in all participant material and advertisements. Any advertisements on Staff Connect without an approval number will be removed.

• The Principal Investigator will immediately report anything that might warrant review of ethical approval of the project to the Ethics Secretariat (Research.Ethics@uts.edu.au).

• The Principal Investigator will notify the UTS HREC of any event that requires a modification to the protocol or other project documents and submit any required amendments prior to implementation. Instructions can be found at https://staff.uts.edu.au/topichub/Pages/Researching/Research%20Ethics%20and%20Integrity/Human%20research%20ethics/Post-approval/post-approval.aspx#tab2.

• The Principal Investigator will promptly report adverse events to the Ethics Secretariat (Research.Ethics@uts.edu.au). An adverse event is any event (anticipated or otherwise) that has a negative impact on participants, researchers or the reputation of the University. Adverse events can also include privacy breaches, loss of data and damage to property.

• The Principal Investigator will report to the UTS HREC annually and notify the HREC when the project is completed at all sites. The Principal Investigator will notify the UTS HREC of any plan to extend the duration of the project past the approval period listed above through the progress report.

• The Principal Investigator will obtain any additional approvals or authorisations as required (e.g., from other ethics committees, collaborating institutions, supporting organisations).

• The Principal Investigator will notify the UTS HREC of his or her inability to continue as Principal Investigator including the name of and contact information for a replacement.

I also refer you to the AVCC guidelines relating to the storage of data, which require that data be kept for a minimum of 5 years after publication of research. However, in NSW, longer retention requirements are required for research on human subjects with potential long-term effects, research with long-term environmental effects, or research considered of national or international significance, importance, or controversy. If the data from this research project falls into one of these categories, contact University Records for advice on long-term retention.

You should consider this your official letter of approval. If you require a hardcopy, please contact Research.Ethics@uts.edu.au.

If you have any queries about your ethics approval or require any amendments to your research in the future, please do not hesitate to contact Research.Ethics@uts.edu.au.

Yours sincerely,

A/Prof Beata Bajorek

Chairperson

UTS Human Research Ethics Committee

C/- Research Office

University of Technology Sydney

E: Research.Ethics@uts.edu.au

REF: E38

**Appendix J**

Ethics Approval from NSW State Education Research Application Process (SERAP)

NSW GOVERNMENT | Education Public Schools

DOC19/819886

**SERAP 2019197**

Dear Mr Jean-Baptiste

I refer to your application to conduct a research project in NSW government schools entitled *How are Preservice Science Teachers Developing their Espoused Theories and Theories-In- Use to Motivate Lower Secondary Science Students?* I am pleased to inform you that your application has been approved.

You may contact principals of the nominated schools to seek their participation. **You should include a copy of this letter with the documents you send to principals.**

This approval will remain valid until 19 September 2020.

The following researchers or research assistants have fulfilled the Working with Children screening requirements to interact with or observe children for the purposes of this research for the period indicated:

**Researcher name WWCC WWCC expires**

Davis Jean-Baptiste WWC0821296E 06-Dec-2021

I draw your attention to the following requirements for all researchers in NSW government schools:

The privacy of participants is to be protected as per the NSW Privacy and Personal Information Protection Act 1998.

- School principals have the right to withdraw the school from the study at any time. The approval of the principal for the specific method of gathering information must also be sought.
- The privacy of the school and the students is to be protected.
- The participation of teachers and students must be voluntary and must be at the school's convenience.
- Any proposal to publish the outcomes of the study should be discussed with the research approvals officer before publication proceeds.
- All conditions attached to the approval must be complied with.

When your study is completed, please upload your report to SERAP online at: http://serap.det.nsw.edu.au. You may also be asked to present on the findings of your research.

I wish you every success with your research. Yours sincerely Dr

Robert Stevens

Production Note:
Signature removed
prior to publication.

**Manager, Research**

**Strategic Assessment | CESE** 19 September 2019

**STRATEGIC ASSESSMENT UNIT | CESE**

**NSW Department of Education**

Level 9, 105 Phillip Street, Parramatta NSW 2150 | GPO Box 33, Sydney NSW 2001

Telephone: 7814 2547 – Email: det.serap@det.nsw.edu.au

## Appendix K

Ethics Approval from the Participating University

HUMAN RESEARCH ETHICS COMMITTEE

Notification of Expedited Approval

To Chief Investigator or Project Supervisor: **Dr Kimberly Pressick-Kilborn**

Cc Co-investigators / Research Students: **Dr Meera Varadharajan Lieutenant Davis Jean-Baptiste**

Re Protocol: **How are Pre-Service Science Teachers Developing their Espoused Theories and Theories-In-Use to Motivate Lower Secondary Science Students?**

Date: **18-Oct-2019** Reference No: **H-2019-0367**

Thank you for your **Response to Conditional Approval (minor amendments)** submission to the Human Research Ethics Committee (HREC) seeking approval in relation to the above protocol.

Your submission was considered under **Expedited** review by the Chair/Deputy Chair.

We are pleased to advise that the decision on your submission is **Approved** effective **18-Oct-2019**.

In approving this protocol, the Human Research Ethics Committee (HREC) is of the opinion that the project complies with the provisions contained in the National Statement on Ethical Conduct in Human Research, 2007, and the requirements within this University relating to human research.

Approval will remain valid subject to the submission, and satisfactory assessment, of annual progress reports. *If the approval of an External HREC has been "noted" the approval period is as determined by that HREC.*

The full Committee will be asked to ratify this decision at its next scheduled meeting. A formal *Certificate of Approval*

will be available upon request. Your approval number is **H-2019-0367**.

**If the research requires the use of an Information Statement, ensure this number is inserted at the relevant point in the Complaints paragraph prior to distribution to potential participants** You may then proceed with the research.

Thank you for your response to the HREC. Whilst we understand you are a student of UTS, per the email correspondence sent to you on 7th August 2019, as you are wanting to recruit students from University A, you need approval from this HREC, hence our need to review your application as such.

Thank you for providing more information and some clarity in relation to our previous request for information, particularly in relation to recruitment and the study phases.

Subsequently this application has been granted approval, pending the address of one minor issue (below): Feedback to researchers:

**1. Participant Information Statement (Pre-service teachers)**

a. In relation to the previous request for information (advise the location of interviews), you responded “As indicated on my application form, there is not specific place where the interviews will be held. While it is hopeful that the interviews will occur in a quiet place in the school’s library, it will be ultimately at a time, mode (including Skype audio or telephone) and place that is convenient to the PST who volunteered to participate in the phase 2 of my research.”

However, your PIS does not convey similar information. Under point 4 in your “risks” Section, it is stated “Safe place for interviews: Interviews will be conducted in school spaces such as in a quiet room in the school the library. The space will be selected at a time that is convenient to you in order to ensure you are safe, non-threatening and you feel free to discuss confidentiality without judgement or disclosure.”

There is no mention that the ultimate choice of a convenient location is up to the participant, nor is there mention of the possibility of choosing to conduct the interview via online medium.

It may be therefore appropriate to update the current PIS accordingly to reflect this information. *If this is the case, could the researchers please provide an amended version of the PIS accordingly.*

**Conditions of Approval**

This approval has been granted subject to you complying with the requirements for *Monitoring of Progress*, *Reporting of Adverse Events*, and *Variations to the Approved Protocol* as detailed below.

PLEASE NOTE:

In the case where the HREC has "noted" the approval of an External HREC, progress reports and reports of adverse events are to be submitted to the External HREC only. In the case of Variations to the approved protocol, or a Renewal of approval, you will apply to the External HREC for approval in the first instance and then Register that approval with the University’s HREC.

***Monitoring of Progress***

Other than above, the University is obliged to monitor the progress of research projects involving human participants to ensure that they are conducted according to the protocol as approved by the HREC. A progress report is required on an annual basis. Continuation of your HREC approval for this project is conditional upon receipt, and satisfactory assessment, of annual progress reports. You will be advised when a report is due.

***Reporting of Adverse Events***

1. It is the responsibility of the person **first named on this Approval Advice** to report adverse events.
2. Adverse events, however minor, must be recorded by the investigator as observed by the investigator or as volunteered by a participant in the research. Full details are to be documented, whether or not the investigator, or his/her deputies, consider the event to be related to the research substance or procedure.
3. Serious or unforeseen adverse events that occur during the research or within six (6) months of completion of the research, must be reported by the person first named on the Approval Advice to the (HREC) by way of the Adverse Event Report form within 72 hours of the occurrence of the event or the investigator receiving advice of the event.
4. Serious adverse events are defined as:

Causing death, life threatening or serious disability. Causing or prolonging hospitalization.

Overdoses, cancers, congenital abnormalities, tissue damage, whether or not they are judged to be caused by the investigational agent or procedure.

Causing psycho-social and/or financial harm. This covers everything from perceived invasion of privacy, breach of confidentiality, or the diminution of social reputation, to the creation of psychological fears and trauma.

Any other event which might affect the continued ethical acceptability of the project.

Reports of adverse events must include, Participant's study identification number; date of birth; date of entry into the study; treatment arm (if applicable); date of event; details of event; the investigator's opinion as to whether the event is related to the research procedures; and action taken in response to the event.

5. Adverse events which do not fall within the definition of serious or unexpected, including those reported from other sites involved in the research, are to be reported in detail at the time of the annual progress report to the HREC.

***Variations to approved protocol***

If you wish to change, or deviate from, the approved protocol, you will need to submit an *Application for Variation to Approved Human Research.* Variations may include, but are not limited to, changes or additions to investigators, study design, study population, number of participants, methods of recruitment, or participant information/consent documentation. **Variations must be approved by the (HREC) before they are implemented** except when registering an approval of a variation from an external HREC which has been designated the lead HREC, in which case you may proceed as soon as you receive an acknowledgement of your Registration.

**Linkage of ethics approval to a new Grant**

HREC approvals cannot be assigned to a new grant or award (ie those that were not identified on the application for ethics approval) without confirmation of the approval from the Human Research Ethics Officer on behalf of the HREC.

Best wishes for a

successful project.

**Human Research Ethics**

**Committee** *For*

*communications and*

*enquiries:*

**Human Research Ethics Administration**

Research & Innovation Services Research Integrity Unit

**Appendix L**

**Survey Data**

# Survey Qualitative
# Analysis
# Synoptic Unit A

Respondent 1 (R1)

**Skipped all Qualitative questions**

espondent 2 (R2)

**.4.** What teaching and learning strategies have you sed to motivate science students during your rofessional experience placements? (Please pecify)

**Several**

**.5.** Grade:1**0**

opic: **Research**

me of day: **5** Resources vailable: **adequate**

ow was the strategy used? **effectively**

**.6** Can you describe what you believe made the esson mentioned in question 5 a successful one? **articipation**

**Q9.** For can you strategy learn du (Please s

**Q10** Ca

**Q11** For previous when yo motivati professi

**Q12** Ca identifie

ntroduction

ɋ14 Can you give me an example to illustrate how one r more of the factors in question 13 influenced the trategies you used to motivate science students to earn? **social media networking**

I5 Can you share some advice for other pre-rvice teachers preparing to teach lower condary science? What can pre-service achers do to motivate science students to learn the lower secondary level? **create buzz oout topic to make it relatable**

Respondent 3 (R3)

**4** What teaching and learning strategies have you sed to motivate science students during your ofessional experience placements? (Please oecify) **Relating to real life concepts - topics I**

**think stu**
**conduct**

**Q5.** Grade

Topic: **For**

Time of da

How was the st

**Q6** Can yo
in questio

**Students v**
**in**

**Q9.** Can y
strategy to
your profe
**Having s**
**(finding c**
**didn't kn**

**Q10** Ca
at that t

he results were not predictable

**11** For any given strategy you have identified in the revious question, can you give me an example of a time when you found those strategies NOT to be effective for motivating science students to learn during your professional experience placements? Please specify)

**When students thought they already knew what would happen so thought the activity was a waste of time**

**12** Can you tell me why you believe the strategy identified question 11 was NOT effective? **Students felt the activity as pointless as they already knew the outcome**

**espondent4 (R4)**

**Skipped all Qualitative questions**

**Q14** Can y
factors in qu
students to

**Thinking**
**enjoyed c**
**Time avai**
**less plann**

**Q15** Can
teachers
What can
students

**Relate it to**
**contributio**

espondent 5 (R5)

**Q4** What teaching and learning strategies have you used to motivate cience students during your professional experience placements? Please specify)

**xplicit instruction, differentiated curriculum, use of concrete naterials**

ɛspondent 6 (R6)

**ɬ4** What teaching and learning strategies have you used to ıotivate science students during your professional ҳperience placements? (Please specify)
**large number of practical activities. A large amount of ŧudent involvement. Relating science concepts to the ŧudents' own lives and possible future careers**

**5.** Grade:7
ɔpic: **Forces**
ıme of day: **Midday**
ɛsources available: **String, plastic bags, tape, paper**
ow was the strategy used? **The students were able to ɛarn about gravity and air resistance through an egg ɾop practical activity. Students were very engaged in ıe task and they had the opportunity to be creative**

**ɬ6** Can you describe what you believe made the lesson ıentioned in question 5 a successful one?

**Q10** Can you te that time? **The c students' were**

**Q11** For any giver give me an examp effective for motiva experience placem **Inquiry learning w could not meet c**

**Q12** Can you tell r was NOT effective **without a high le**

**Q14** Can you give factors in question science students t **Other preservice teaching strategi**

tudents felt they could experiment. There was a high level of

Q15 Can you sh

reparing **student direction. There was a level of competition.**

to teach lower se

iotivate science students to learn at the lower secondary level?

**!9** For any strategy you have used in the previous question, can you **Integrate as ma**
ve me an example of a time when you found that strategy to be effective in motivati
our professional experience placements? **when working in groups students fe**
**iore confidence**

**espondent 7 (R7)**

Skipped all Qualitative questions

espondent 8 (R8)

**4** What teaching and learning strategies have you used to motivate cience students during your professional experience placements? Please specify)

**ncorporation of relevant technology in their work (not necessarily in he classroom)**

**larifying the relevance of the ideas and concepts taught to their veryday lives and how to apply these to solve real-world problems**

**5.** Grade:8

opic: **Circulatory/Respiratory Systems**

me of day: **Afternoon**

esources available: **Digital devices for recording data, Pulse ximeter** How was the strategy used? **Using a pulse oximeter to neasure heart rate and oxygen levels in students before and after hysical activity**

**6** Can you describe what you believe made the lesson mentioned in estion 5 a successful one?

**It was n**
**physica**
**Incorpo**
**chance**
**devices**

**Q10** Ca
time?

**It was e**
**last per**
**was imp**
**physica**

**Q14** Ca
factors i
science

**Talking**
**various**
**exampl**
**importa**

**Q15** Ca
prepari

eachers do to motivate science students to learn at the lower secondary vel?

9 For any strategy you have used in the previous question, can you give me example of a time when you found that strategy to be effective in motivating ience students to learn during your professional experience placements?

**etailed in a previous question?**

**Studen day. In must b**

**Respondent 9 (R9)**

Skipped all Qualitative qu

espondent 10 (R10)

4 What teaching and learning strategies have you used to notivate science students during your professional xperience placements? (Please specify) **Use of students eing in small groups for collaboration. Use of owerpoint to engage students in learning. Use of ncouragement to help students move towards earning content and skills**

**5.** Grade:8

opic: **Travel Graphs**

me of day: Morning

esources available: **Power Point**

6 Can you describe what you believe made the lesson mentioned question 5 a successful one**? Students were engaged with the ontent and successfully completed a subsequent work sheet n the content taught**.

9 For any strategy you have used in the previous question, can ou give me an example of a time when you found that strategy to e effective in motivating science students to learn during your

How was the stra

**teach the sub-to**

**concept of use o**

**Q10** Can you tell

time?

**Students were a**

**other while I che**

**Q14** Can you give

factors in questio

science students

**The supervising**

**motivate studen**

**observe the sup**

**to generate moti**

Skipped all Qualitative qu

rofessional experience placements? (Please specify) **Group work llows students to relate the content to each other. In this way ney are talking about the content rather than having the eacher direct them in a particular way.**

**Respondent 11 (R11)**

Skipped all Qualitative questions

espondent 12 (R12)

**4** What teaching and learning strategies have you sed to motivate science students during your rofessional experience placements? (Please specify)

**ractical tasks, real life applications or comparison**

Skipped all Qualitative questions

**Respondent 13 (R13)**

Skipped all Qualitative questions

espondent 14 (R14)

4 What teaching and learning strategies ve you used to motivate science students ring your professional experience acements? (Please specify) **Student-ntred learning/activity creation**

**5.** Grade:7
opic: Chemical World- Chromatography
me of day: Afternoon
esources available: f**ilter paper, water-soluble textas, beakers, ater**
ow was the strategy used? **I asked them to design an experiment test the solubility of the different coloured textas, and the dividual colours in each individual texta. Concluding, they needed identify which was most soluble and which was least. I gave em a scaffold for the scientific report**

6 Can you describe what you believe made the lesson mentioned question 5 a successful one?
**e excitement of the students having power over the lesson, ief direct instruction to introduce the activity, propriate/effective equipment.**

**Q9** For any st give me an ex effective in m experience pl **when studen of the day wl**

**Q10** Can you t time? **As the s**

**Q11** For any g can you give m NOT to be effe professional ex **After lunch, w working or be**

**Q12** Can you t was NOT effec **or more intere**

Skipped all Qualitativ

l**4** Can you give me an example to illustrate how one or more of the ctors in question 13 influenced the strategies you used to motivate ience students to learn?
**/ supervising teacher had previously undertaken similar tivities and helped me shape my lesson, she gave me ideas, edback and instructions.**

l**5** Can you share some advice for other pre-service teachers eparing to teach lower secondary science? What can pre-service achers do to motivate science students to learn at the lower condary level? **Give the students autonomy over their arning, allow them space to create their own lessons and ve fun with their learning.**

Skipped all Qualitativ

espondent 15 (R15)

**4** What teaching and learning strategies have you sed to motivate science students during your rofessional experience placements? (Please pecify)
**laking the topics and activities appealing to tudents is very important although it can be ifficult.**

**5.** Grade:7
pic:Circuits
me of day: Morning
esources available: **Prac equipment. LED light bulbs, opper, iron and lemons**
ow was the strategy used? **Students been uninterested in ectricity and it's movement, to engage them and get e students thinking the were asked to make a lemon attery and observe what happened and hypothesize hy it happened**

**6** Can you describe what you believe made the lesson mentioned in uestion 5 a successful one?
**etting students to engage as well as giving them something teresting yet related to the topic to think about made the sson successful**

**Q9** For a
give me
effective
experien
**See que**
**Q10** Can
time? **It c**
**why the**

**Q11** For
can you
NOT to b
professio
**When st**
**member**
**to gain t**

**Q12** Can
was NOT

espondent 16 (R16)

**.4** What teaching and learning strategies have you used to motivate cience students during your professional experience placements? Please specify)

**have used multi modal delivery methods. For example in an xtended lesson on scientific models I used a visual interactive emonstration, with student helpers, to model the distance etween the Earth, ISS and Moon. Students were then placed in roups to make LEGO model Earth, Sun and Moon orrerys. The roups then presented their models and demonstrated how they orked to the class. Some students started to make links to the ummer and slwinter solstices. We then had a class discussion n what makes a good model.**

**5.** Grade:7
opic: Earth and space
me of day: Morning
esources available: **LEGO, string, balls**
ow was the strategy used? **Offering different mediums and tudent choice.**

**.6** Can you describe what you believe made the lesson mentioned in uestion 5 a successful one? **Hands on activities, movement round the classroom. Collaborative learning.**

**Q9** For a
me an ex
motivatin
placeme
**Students**
**model w**
**off their**

**Q10** Ca
time?
**The les**
**felt brea**
**Adding**

**Q11** For
can you
NOT to b
professio
**When le**
**LEGO ar**
**with, thr**

**Q12** Can
was NOT

**Q14** Can
factors in
science s

**ly students all had laptops in every lesson, so by morn using hem it make the lesson have a point of difference.**

**15** Can you share some advice for other pre-service teachers reparing to teach lower secondary science? What can pre-service

teachers

**world. M**

**demons**

**concept**

**underst**

**espondent 17 (R17)**

Skipped all Qualitative questions

espondent 18 (R18)

4 What teaching and learning strategies have you used to motivate
ience students during your professional experience placements?
lease specify) **videos, models, humor**

espondent 19 (R19)

**Q4** What teaching and learning strategies have you used to motivate science students during your professional experience placements? (Please specify)

**I have only had observational placement so far, but during my observations I used guiding questions to assist students that weren't quite sure how to proceed.**

**Q5** Can you choose one strategy that you provided in Question 4 and describe the lesson/context in which you successfully used that strategy?

Grade: **10**

Topic: **Biology**

Time of day: morning or afternoon: **Afternoon**
Resources available: **None**
How was the strategy used? **Through verbal suggestion**

espondent 20 (R20)

**.4** What teaching and learning strategies have you used to motivate cience students during your professional experience placements? Please specify)
**cience experiments where possible, using different teaching iethods throughout the lesson**

**.5** Can you choose one strategy that you provided in Question 4 and escribe the lesson/context in which you successfully used that strategy?
rade: **8**
opic: **Earth Science 3**
ime of day: morning or afternoon: Afternoon
esources available: **Videos, handout activities, smartboard** How as the strategy used? **Lesson consisted of some note taking, ollowed by class discussion on what students thought, a short lm that related to the topic with a worksheet and then a simple emonstration for the class**

**.6** Can you describe what you believe made the lesson mentioned in uestion 5 a successful one?

**Changin on the sl ways (no**

**Q9** For a me an ex motivatin placemen
**Experime bring the**
**Q10** Can time?
**The stud was told**

**Q14** Can factors in science s
**Advice fr before a**

espondents 21-23 (R21-R23)

Skipped all Qualitative questions

**Respondent 24 (R24)**

Q9 For ar

give me an example of a time when you found that strategy to

ou used to motivate motivating science students to learn during your professional ex

acements? (Please placements? (Please specify)

specify) **with higher achieving students, allowing more discoverybased learning styles that focus on implementing more higher order skills (such as critical thinking and problem solving); delivering content (theory) using a range of modes and learning styles within that one lesson.**

**part of a r**

**occupatio**

**Q10** Can t

time?

**it involve**

**that could**

**(instead o**

**informatio**

**examples**

**students**

**Q5** Can you choose one strategy that you provided in Question 4 and describe the lesson/context in which you successfully used that strategy?

rade: **9 (bottom class)**

opic: **Biology**

me of day: morning or afternoon: **last period**

esources available: **scaffolded worksheets to be using in conjunction ith a video on spheres.**

ow was the strategy used? **students were given worksheets that they eeded to complete whilst watching a YT video. worksheets only equired students to fill in the blanks and the video was paused as nswers came up.**

**Q11** For a

can you gi

NOT to be

professiona

**when they**

**required to**

**ability clas**

**Q14** Can yo

factors in q
science stu

.6 Can you describe what you believe made the lesson mentioned in
uestion 5 a successful one?

**advice give**

**irly low order tasks, so students weren't overwhelmed, the video**

**relationsh**

**asn't bland and boring and the info was concise and not convoluted. classroor**

**Q15** Can you share some advice for other
to teach lower secondary science? What
motivate science students to learn at the l

**lots of hands on discovery (pracs)**

**espondent 25 (R25)**

Skipped all Qualitative questions

**espondent 26 (R26)**

Skipped all Qualitative questions

espondents 27-28 (R27-R28)

Disqualified

espondent 29 (R29)

4 What teaching and learning strategies have you sed to motivate science students during your rofessional experience placements? (Please specify) **I ave used experiments and using models. I have lso made science relevant to them by giving veryday life examples of concepts being taught.**

5 Can you choose one strategy that you provided in Question 4 and escribe the lesson/context in which you successfully used that rategy?

rade:8

opic: **Circulatory and Respiratory Systems**

me of day: morning or afternoon: Morning

esources available: **Models, PowerPoint presentation/video and harts**

ow was the strategy used? **The model was used to demonstrate ow the circulatory system works and the charts were used to ve them a visual representation of the various systems. The owerPoint presentation with video was used to show and xplain how the systems work and to make it meaningful to them.**

**Q6** Can y
question 5
**were able**

**Q9** For an
me an exa
motivating
placemen
**With rega**
**able to he**
**were also**

**Q10** Can
time? **Bec**

**Q11** For a
can you g
NOT to be
profession
**tasks son**

**Q12** Can
was NOT
**with their**

**14** Can you give me an example to illustrate how one or more of the ctors in question 13 influenced the strategies you used to motivate cience students to learn?
**got ideas on Twitter from engaging with my PLN groups.**

**Q15** Can
to teach le
motivate s
**can talk t**
**motivate**

espondent 30 (R30)

**4** What teaching and learning strategies have you used motivate science students during your professional xperience placements? (Please specify) **I used videos to how concepts**

espondent 31 (R31)

**4** What teaching and learning strategies have you used motivate science students during your professional xperience placements? (Please specify) **charts (visual ids), use of models to show different types of rocks gneous, sedimentary, metamorphic)**

**5** Can you choose one strategy that you provided in Question 4 and escribe the lesson/context in which you successfully used that strategy?
rade:9
opic: **Earth and Space**
me of day: morning or afternoon: Afternoon Resources available: **rock mples, charts, worksheets the charts were used to show the atures of the different types of rocks; the worksheets contained e features of the sample rocks and the students were placed in oups to use the sample rocks to complete**

**6** Can you describe what you believe made the lesson mentioned in uestion 5 a successful one?
**ne use of the actual sample of the rocks. the students were able relate the features of the rock with the sample that was being sed in class so they would be able to identify them in the real orld**

**9** For any strategy you have used in the previous question, can you give e an example of a time when you found that strategy to be effective in otivating science students to learn during your professional experience

placeme
**membe**
**other. s**
**during t**
**Q10** Ca
at that ti
**in the a**
**use of a**
**setting**

**Q11** For
questio
those st
to learn
specify)
**become**
**will be i**
**concep**

**Q12** Ca
was NO
**of the le**

**Q14** Ca
factors i
science

**ıe feedback from supervising teachers is always effective as onstructive feedback is usually given. it is also important to get uggestions from other teachers on how to teach a particular topic specially if they have years of experience and have taught that esson several times.**

**.15** Can you share some advice for other pre-service teachers preparing › teach lower secondary science? What can pre-service teachers do to notivate science students to learn at the lower secondary level?
**is always important to get feedback from other teachers on how you an improve a topic being taught**

espondent 32 (R32)

**.4** What teaching and learning strategies have ou used to motivate science students during your rofessional experience placements?
Please specify) **experiments**

**.5** Can you choose one strategy that you provided in Question 4 and escribe the lesson/context in which you successfully used that trategy?
rade:8
opic: **Living World - Classification**
ime of day: morning or afternoon: **Morning**
esources available: **YT video, sample organisms, charts** How as the strategy used? **the YT video was used to show the easons why living things are classified and the charts were**

**used to**
**things.**

**Q6** Can
question
**classify**

**Q9** For a
give me
effective
professi
**experim**
**(science**

**Q10** C
at that
**in the**
**activit**

**Q11** F
questio
those
to lear
specify
**stude**
**when**

**Q12** Can you tell me why you believe the strategy identified in question 11 was NOT effective? **some students who are considered weak prefer to work in groups as they are able to learn from their peers**

**14** Can you give me an example to illustrate how one or more of the ıctors in question 13 influenced the strategies you used to motivate cience students to learn? **the availability of resources to conduct essons plays a major part in which strategy is used. the more esources available to teach a lesson the easier it is to include all ne students to participate and they will be excited to learn**

**15** Can you share some advice for other pre-service teachers reparing to teach lower secondary science? What can pre-service eachers do to motivate science students to learn at the lower econdary level? **the more they use real life examples to bring cross concepts to students the more relatable it will be to them nd they will be motivated to learn.**

espondent 33 (R33)

**4** What teaching and learning strategies have you used to motivate cience students during your professional experience acements? (Please specify) **Charts nd demonstrations**

**5** Can you choose one strategy that you provided in Question 4 and escribe the lesson/context in which you successfully used that strategy?

Grade: 7
Topic: **E**
Time of
Resourc
strategy
**sun, mo**
**further**

**Q9** For a
me an e
motivatin
placeme
**In the m**
**compet**
**answers**

**Q10** Can
time? **Th**

**Q11** Fo
can you
NOT to
profess
**There a**
**studen**
**I would**

giving hints or reviewing certain topics to help them write the correct answers.**

**Q12** Can you tell me why you believe the strategy identified in question 11 was NOT effective? **The students did not seem to grasp the lesson and would have benefited better if another strategy was used.**

**Q14** Can you give me an example to illustrate how one or more of the factors in question 13 influenced the strategies you used to motivate science students to learn?
**There are times when we have 40 minutes to complete a lesson. This is one of the main factors that determines which strategy I use. Additionally if there is limited resources I usually resort to visual aids or simple demonstrations instead of using individual activities.**

**Q15** Can you share some advice for other pre-service teachers preparing to teach lower secondary science? What can pre-service teachers do to motivate science students to learn at the lower secondary level? **Use what motivated them as young science students to motivate their current students. Technology is always a good tool to use as well.**

Respondent 34 (R34)

**Q4** What teaching and learning strategies have you used to motivate science students during your professional experience placements? (Please specify) **demonstrations**

**Q9** For a... me an e... motivati... placeme... **student... each ot...**

espondent 35 (R35)

4 What teaching and learning strategies have you used to notivate science students during your professional xperience placements? (Please specify) **Giving real life xamples/situations**

6 Can you describe what you believe made the lesson mentioned in uestion 5 a successful one? **The real life examples which the tudents and I came up with**

**Q12** Can you tell me why you believe the strategy identified in question 11 was NOT effective?
**This is because the students would be disrupting each other, going off topic most times and not focused on the activity at hand**

11 For any given strategy you have identified in the previous uestion, can you give me an example of a time when you found those rategies NOT to be effective for motivating science students to learn uring your professional experience placements? (Please specify) **realized that sometimes when I place students in groups, they re not as productive as they would be when they work with a eer of their choosing**

14 Can you give me an example to illustrate how one or more f the factors in question 13 influenced the strategies you used motivate science students to learn?

**Normally w lot to conve lesson, I wi ensure stu**

**Q15** Can yo preparing to teachers do secondary le **Although I**

**concepts d students w**

espondent 36 (R36)

**.4** What teaching and learning strategies have you sed to motivate science students during your rofessional experience placements? (Please pecify) **Scaffolding and guided inquiry**

**.5** Can you choose one strategy that you provided in Question and describe the lesson/context in which you successfully sed that strategy? Grade:7
opic: Mixtures
ime of day: morning or afternoon: Morning
Resources available: **funnel, sand, water, flask, charts** How was e strategy used? **a demonstration was done using the esources. the students then carried out a group activity hich required them to apply the lesson taught on separation f mixtures**

**.6** Can you describe what you believe made the lesson mentioned in uestion 5 a successful one?
**he method used. The demonstration was done and then the tudents were able to carry out a similar task successfully.**

**.9** For any strategy you have used in the previous question, can you ive me an example of a time when you found that strategy to be

effective in r
experience
**An experim**
**science in a**
**Q10** Can yo
**They are us**

**Q11** For any
you give me
effective for
experience
**If resources**
**you will hav**
**concepts b**

**Q12** Can yo
was NOT ef
**concepts a**

**Q14** Can yo
in question
to learn?
**PST chat or**
**science les**

**15** Can you share some advice for other pre-service teachers reparing to teach lower secondary science? What can pre-service eachers do to motivate science students to learn at the lower econdary level? **Always learn from other teachers and don't be fraid to ask supervising teachers for suggestions on how to eliver a lesson**

espondent 37 (R37)

**4** What teaching and learning strategies have you used to notivate science students during your professional experience acements? (Please specify) **Technology- se of videos, flip charts**

**5** Can you choose one strategy that you provided in Question 4 and escribe the lesson/context in which you successfully used that trategy?
rade:8
opic: States of matter
ime of day: morning or afternoon: Afternoon
esources available: **stones, water, ice, heat source, videos**
ow was the strategy used? **the video was used to show how ome substances change from one state to another**

**6** Can you describe what you believe made the lesson mentioned in uestion 5 a successful one? **Video was informative and real life ubstances were used to show the different states of matter**

**Q9** For any
an example
motivating s
placements
**relate them**
tell me why
was effectiv
**they work b**
**afternoon a**
**participate**

**Q14** Can yo
factors in qu
science stuc
**Technology**
**classes. Fo**
**in a lab, bu**

**Q15** Can yo
teach lower
science stuc
**technology**
**at the lowe**

espondent 38 (R38)

**4** What teaching and learning strategies have you used to notivate science students during your professional experience acements? (Please specify)
**/orking in groups and**
**/orksheets**

**5** Can you choose one strategy that you provided in Question and describe the lesson/context in which you successfully sed that strategy?
rade:8
opic: Cells
ime of day: morning or afternoon: Afternoon
esources available: **worksheets, visual aids** How was the trategy used? **students were given worksheets to omplete after the lesson was taught**

**6** Can you describe what you believe made the lesson nentioned in question 5 a successful one? **Students were ble to distinguish the different type of cells (animal or lant) when they completed the worksheet**

**9** For any strategy you have used in the previous question, can you ive me an example of a time when you found that strategy to be ffective in motivating science students to learn during your rofessional experience placements? (Please specify)

**Good feedb**
**understand**
**them.**
**Q10** Can yo
**Some stude**
**groups for**

**Q11** For any
can you give
NOT to be e
professiona
**worksheets**
**challenge i**

**Q12** Can yo
was NOT ef

**Q14** Can yo
in question
to learn?
**I always try**
**make the s**

**15** Can you share some advice for other pre-service teachers reparing to teach lower secondary science? What can pre-service eachers do to motivate science students to learn at the lower econdary level?

**Use ideas f will be mot**

**espondent 39 (R39)**

Skipped all Qualitative questions

espondent 40 (R40)

**.4** What teaching and learning strategies have you used to motivate cience students during your professional experience placements? (Please pecify)
**use citizen science as well as a lot of group work**

**.5** Can you choose one strategy that you provided in Question 4 and escribe the lesson/context in which you successfully used that strategy?
rade:9
opic:Ecosystems
ime of day: morning or afternoon: Morning
esources available: Nature, charts, computer
**placed students in groups and we went on an ecological walk around ne school in order to identify interactions between organism in the nvironment**

**.6** Can you describe what you believe made the lesson mentioned in uestion 5 a successful one? **The students were able to see organisms n the environment in real life and relate it to what they see on a daily asis**

**.9** For any strategy you have used in the previous question, can you give ne an example of a time when you found that strategy to be effective in

motiva
experie
**I find t**
**more l**
**Q15** C
prepar
teache
secon
**I woul**
**try it c**

Respondent 41 (R41)

**.4** What teaching and learning strategies have you used
› motivate science students during your professional
xperience placements? (Please specify) **concept maps,**
**allery walk**

**.5** Can you choose one strategy that you provided in Question 4 and
escribe the lesson/context in which you successfully used that strategy?
rade:9
opic: **Particles of Matter**
ime of day: morning or afternoon: **afternoon**
esources available: **charts, video, worksheets**
ow was the strategy used? **Charts were placed in the classroom and**
**ie students were given worksheets to complete using the**
**formation posted on the walls. They also watched the videos**
**eproduced the drawings of the arrangement of particles in matter. Q6**
an you describe what you believe made the lesson mentioned in **Q10** Can
ou tell me why you believe the strategy was effective at that time?
uestion 5 a successful one? **the ability of the students to move around that will b**
**me while collecting still participating in the learning process** **than others.**

**studer**
**effecti**

**Q11** F
questi
those
studer
(Pleas
**an exp**

**Q12** C
questi

**Q14** C
factors
scienc
**lessor**

**.9** For any strategy you have used in the previous question, can you give ıe an example of a time when you found that strategy to be effective in ıotivating science students to learn during your professional experience acements? (Please specify)

**Q15** Can yo to teach lo motivate sc

**always hav**

**ıey are often excited when they are able to do activities allows them be willing t › work with their peers and learn from each other.**

espondent 42 (R42)

Disqualified

espondent 43 (R43)

**4** What teaching and learning strategies have you used to motivate cience students during your professional experience placements? (Please pecify)
**ole play, models, demonstrations**

**5** Can you choose one strategy that you provided in Question 4 and escribe the lesson/context in which you successfully used that strategy?
rade:9
opic: **Considering how energy flows into and out of the cosystem and how it must be maintained** Time of day: morning or fternoon:**morning**
esources available: **video, models food chain and food web, orksheet with animals and plants for activity**
ow was the strategy used? **the video was used to show how different rganisms contribute to the energy flow in the ecosystem. A model ood chain and web was used to further explain the lesson. The orksheets were distributed individually with an activity for them to omplete.**

**6** Can you describe what you believe made the lesson mentioned in uestion 5 a successful one**? It engaged all the students at different oints throughout the lesson so no one was left out.**

**Q9** For me an e motivat placeme
**Using a studen the cor**
**Q10** Ca time? **Ir are to l**

**Q11** Fo questio strategi during y
**Some l how ec better i from ea**

**Q12** Ca 11 was **their ov**

**14** Can you give me an example to illustrate how one or more of the
ctors in question 13 influenced the strategies you used to motivate
ience students to learn?
**ne availability of resources determines which strategy is used. The
ore resources available the better. Group activities are used when
esources are limited**

**15** Can you share some advice for other pre-service teachers preparing
teach lower secondary science? What can pre-service teachers do to
otivate science students to learn at the lower secondary level?
**y and understand the type of students you have and plan your
sson so that no one is left out**.

espondent 44 (R44)
**4** What teaching and learning strategies have you used to motivate
ience students during your professional experience placements?
lease specify)
**nave used powerpoint presentation, charts I have also used given
e students praise when they do well on assignments.**

**5** Can you choose one strategy that you provided in Question 4 and
escribe the lesson/context in which you successfully used that strategy?
rade:8
opic: **cells(plant and animal cells)**
me of day: morning or afternoon: **afternoon**
esources available: **charts, powerpoint with video**

How wa
**about p
the diff
the two
cells in**

**Q6** Can
questio
**I Believ
their fir**

**Q9** For
give me
effective
experie
**I realize
tasks, t
the clas
and tha**
**Q10** Ca
time?
**I think r
continu
workin**

**Q11** Fo
can you

OT to be effective for motivating science students to learn during your ofessional experience placements? (Please specify) **when student are groups they get distracted and don't work efficiently most times**

**12** Can you tell me why you believe the strategy identified in question 11 as NOT effective? **because they talk to much and joke around during ass**

**14** Can you give me an example to illustrate how one or more of the ctors in question 13 influenced the strategies you used to motivate ience students to learn?
**usually like teaching the way I was taught when I was younger. I elieve that if it motivated me, it will also motivate the students whom each. I am also guided on the best ways to teach from my friends nd family some of whom were teachers**

**15** Can you share some advice for other pre-service teachers preparing teach lower secondary science? What can pre-service teachers do to otivate science students to learn at the lower secondary level? **I believe at you should follow your heart and get to know your students and eir background before you're teach. Also listen to advice from other xperience teachers**

espondent 45 (R45)

**4** What teaching and learning strategies have you used to otivate science students during your professional

experie
**demon**

**Q5** Can
describ
strategy
Grade:
Topic: **E**
**Transfo**
Time of
availabl
How wa
**types c**
**the less**
lesson
**level**

**Q9** For
me an e
motivat
placeme
**differe**
strategy

**11** For any given strategy you have identified in the previous
iestion, can you give me an example of a time when you found
ose strategies NOT to be effective for motivating science students to
arn during your professional experience placements? (Please
oecify) **equipment did not work at the time**

**12** Can you tell me why you believe the strategy identified in question 11
as NOT effective? **because the equipment failed the student's
tention span and interest was not held for too long**

**14** Can you give me an example to illustrate how one or more of the
ctors in question 13 influenced the strategies you used to motivate
cience students to learn?
**ecause of the difference in cultural backgrounds I had to use
fferentiated instruction and give examples that are culturally
levant to the students**

**15** Can you share some advice for other pre-service teachers preparing
teach lower secondary science? What can pre-service teachers do to
otivate science students to learn at the lower secondary level?
**asically to know your students, where they are at so that you could
an for them**.

Respond

**Q4** Wha
motivat
placem
**group v**

**Q5** Can
describ
Grade:7
Topic:
**substar**
Time of
Resourc
How wa
**I just us
time**

**Q6** Can
questio
**what th**

**Q9** For
me an e
motivat
placem

**hen I use group work the students are keen to help each other learn**
**oout the concepts**
**10** Can you tell me why you believe the strategy was effective at that
ne? **was effective because the students helped each other to**
**scover how to separate different mixtures, for example separating**
**and from water or colours using paper chromatography**

**11** For any given strategy you have identified in the previous
uestion, can you give me an example of a time when you found
ose strategies NOT to be effective for motivating science students to
arn during your professional experience placements? (Please
pecify) **sometimes when I give students individual task to**
**omplete they would not be too keen on completing them**
**ithout their mate's assistance**

**12** Can you tell me why you believe the strategy identified in question 11
as NOT effective? **it wasn't effective because students usually like**
**orking in groups.**

**14** Can you give me an example to illustrate how one or more of the
ctors in question 13 influenced the strategies you used to motivate
cience students to learn?
**eas on how to motivate students from Twitter and Pinterest**

**15** Can you share some advice for other pre-service teachers preparing
teach lower secondary science? What can pre-service teachers do to

motivat
**say usi**
**motivat**
**ideas fr**

Respond

**Q4** Wha
used to
profess
**have us**

**Q5** Can
describ
Grade:7
Topic: E
Time of
Resour
How wa
**explain**
**were sl**
**rotates**

**Q6** Can
questio

**ıe students were able to see real life recorded videos from the ternational space station showing a time lapse video of the earths ɔtation. The students were very curious to learn**.

**9** For any strategy you have used in the previous question, can you give e an example of a time when you found that strategy to be effective in otivating science students to learn during your professional experience acements? (Please specify)
**ıst like in the rotation lesson. I used demonstration to show :udents how the earth rotates around the sun**
**ı10** Can you tell me why you believe the strategy was effective at that me**? It was effective because the students were very interested in earning about the earth**

**14** Can you give me an example to illustrate how one or more of the ctors in question 13 influenced the strategies you used to motivate :ience students to learn?
**bviously if there are no resources, I am "not" able to do much. I do hat I can at the time with what I have**

**15** Can you share some advice for other pre-service teachers preparing teach lower secondary science? What can pre-service teachers do to otivate science students to learn at the lower secondary level?
**would advise that you use your environment as much as possible if ɔu don't have resources. Also there are some nice resources online.**

espondent 48 (R48)2 2

Disqualified

**espondent 49 (R49)2 2**

Skipped all Qualitative questions

**espondent 50 (R50)42 42**

Skipped all Qualitative questions

What teaching and learning strategies have you used to
otivate science students during your professional

espondent 51 (R51)

**4**

xperience placements? (Please specify)
**roup work, experiments, demonstrations**

**5** Can you choose one strategy that you provided in Question 4
nd describe the lesson/context in which you successfully used that
rategy? Topic: Cells
me of day: morning or afternoon: Morning
esources available: **PowerPoint charts**
ow was the strategy used? **I used the charts to show students the
ifference between plant and animal cells**

**6** Can you describe what you believe made the lesson mentioned in
uestion 5 a successful one?
**elieve that relating the cells to trees and animals helped the
tudents develop a better understanding for the content**

**9** For any strategy you have used in the previous question, can you give
e an example of a time when you found that strategy to be effective in
otivating science students to learn during your professional experience
acements? (Please specify)

**I have fo
students
encoura**
**Q10** Can
time? **It w**

**Q14** Can
factors in
science s
**For insta
demonst
separatio**

**Q15** Can
to teach
motivate
**are many
that I fin
many th**

Responde

**Q4**

What teaching and learning strategies have you used to
otivate science students during your professional
xperience placements? (Please specify)
**nave motivated students by encouraging them to keep working nd also by giving them real life examples**

**5** Can you choose one strategy that you provided in Question 4 and escribe the lesson/context in which you successfully used that strategy?
rade:7
opic: **Earth's renewable resources - Water Cycle**
me of day: morning or afternoon: **Morning**
esources available: **charts, video presentation, worksheet** How was e strategy used? **Students watched the video of the water cycle and ere given a worksheet to complete**

**6** Can you describe what you believe made the lesson mentioned in uestion 5 a successful one?
**tudents were able to relate to the different uses of water and were ager to learn more about it**

**9** For any strategy you have used in the previous question, can you give e an example of a time when you found that strategy to be effective in otivating science students to learn during your professional experience acements? (Please specify)
**tudents are always happy to work with their friends in groups**.
**10** Can you tell me why you believe the strategy was effective at that me? **the students were alert and looked forward to the lesson**

**Q11** For
question,
those stra
to learn c
specify) v
**students**
**together**

**Q12** Can
was NOT
**when do**
**their ma**
**their ow**

**Q14** Can
factors in
science s
**determir**
**there are**
**lesson w**

**Q15** C
prepa
teache
secon

What teaching and learning strategies have you used to otivate science students during your professional

**complete and plan activities that can be completed during the allotted. Students will be better able to apply the concepts taught when activities are done to completion and questions that they may have are answered.**

espondent 53 (R53)

**4**

xperience placements? (Please specify) **models, ole play, charts**

**5** Can you choose one strategy that you provided in Question 4 and escribe the lesson/context in which you successfully used that rategy?
rade:8
opic: **Properties of different states of matter**
me of day: morning or afternoon: **Afternoon** Resources vailable: **models, cards for activity, powerpoint resentation**
ow was the strategy used? **Presentation was used to explain the ifferent states of matter and how particles are arranged in each. ards were used to complete the activity which required them to lentify the correct state (solid, liquid or gas) of the images on the ard.**

**Q6** Can y in questic **students**

**Q9** For a me an ex motivatin placemer **students that I giv** time? **wh prevents**

**Q11** For can you g NOT to b professic **limited r When I w liquid-ga enough**

**Q12** Can was NOT

What teaching and learning strategies have you used to otivate science students during your professional

**14** Can you give me an example to illustrate how one or more of the ctors in question 13 influenced the strategies you used to motivate cience students to learn?

**bserving other science teachers and asking how they delivered a articular lesson is always good. You can use the best method that ould make your students want to participate and learn more about cience concepts.**

**15** Can you share some advice for other pre-service teachers preparing teach lower secondary science? What can pre-service teachers do to otivate science students to learn at the lower secondary level? **Consult ith other teachers to get ideas on which strategies work best for ertain topics**.

Q10 Car

What teaching and learning strategies have you used to
otivate science students during your professional

espondent 54 (R54)

4

xperience placements? (Please specify) **Giving**
**xamples relating to things they may know**
**sing models**

**5** Can you choose one strategy that you provided in Question 4 and
escribe the lesson/context in which you successfully used that strategy?
rade:8
opic: **Gas Exchange**
me of day: morning or afternoon: **Afternoon**
esources available: **models, Balloons, PowerPoint and video** How
as the strategy used? **The students were given 2 balloons so that**
**ey can use to simulate lungs by inflating them with air. The**
**deo showed the students what happens during gaseous**
**xchange.**

**6** Can you describe what you believe made the lesson mentioned in
uestion 5 a successful one?
**ngagement with the balloons. It was new to them and they had fun**
**ith it**

**Q9** For a
me an e
motivati
placeme
**The stu**
**to get th**
**other le**
time? **Bo**
**mates t**
**taught.**

**Q11** For
can you
NOT to
professi
**I have fo**
**lesson i**

**Q12** Car
was NO
**I have fo**
**lesson i**

What teaching and learning strategies have you used to
otivate science students during your professional

**14** Can you give me an example to illustrate how one or more of the ctors in question 13 influenced the strategies you used to motivate ience students to learn?
**bviously if you knw what students believe and value then you will e able to plan your lesson around that so they can learn better**

**15** Can you share some advice for other pre-service teachers eparing to teach lower secondary science? What can pre-service achers do to motivate science students to learn at the lower secondary vel? **Maybe if something worked for you as a student, it might ork for your students also. Think about what motivated you to arn science**

espondent 55 (R55)

**4**

perience placements? (Please specify)
**xperiments, Simulation**

**5** Can you choose one strategy that you provided in Question 4 and escribe the lesson/context in which you successfully used that rategy?
rade:9
opic: Chemical reactions:Acids with metals

Time of
available
**magnes**
How wa
**that aci**
**They co**
**exchan**

**Q6** Can
question
**It is kno**
**be excit**

**Q9** For a
me an e
motivatin
placeme
**I know t**
**I always**
**will incr**
time?I **k**
**effectiv**
**works.**

**Q11** For
question
strategie

What teaching and learning strategies have you used to
otivate science students during your professional
uring your professional experience placements? (Please specify) **My**
**rategies are always effective because I know my students. If**
**ere are limited resources I think that would affect my lesson in**
**bad way as I would have to do a demonstration instead of the**
**udents doing their own experiments.**

**12** Can you tell me why you believe the strategy identified in question 11
as NOT effective?
**you are not participating in an activity it is easy to lose interest so**
**ome students would not benefit from a demonstration.**

**14** Can you give me an example to illustrate how one or more of the
ctors in question 13 influenced the strategies you used to motivate
cience students to learn?
**s a teacher it is always good to take time to plan and carry out your**
**periments. So preparation time is very important.**

**15** Can you share some advice for other pre-service teachers preparing
teach lower secondary science? What can pre-service teachers do to
otivate science students to learn at the lower secondary level?
**would say always be prepared for all your classes and know the**
**pe of students that you are preparing for**.

Responde

**Q4**

experien
**experim**

**Q5** Can
describe
Grade:7
Topic: **E**
Time of
Resourc
the strat
**very en**
**asked w**
**When th**
**has the**
**and a P**

**Q6** Can
question
**It was b**
**object t**
**the less**

What teaching and learning strategies have you used to
otivate science students during your professional

**9** For any strategy you have used in the previous question, can you give e an example of a time when you found that strategy to be effective in otivating science students to learn during your professional experience acements? (Please specify**) I remember teaching different states of atter and students had their crossword puzzles to find various ords and then classify those words as being either belonging to a olid liquid or gas. They did a peer evaluation afterward since they hared their responses with their friends.**

**10** Can you tell me why you believe the strategy was effective at that ne? **It was the engagement and the curiosity to find the word and en classify it accordingly. Also sharing it with their friends led to scussion and then justifying their classifications**

**14** Can you give me an example to illustrate how one or more of the ctors in question 13 influenced the strategies you used to motivate cience students to learn?
**e strategy I use mainly depends on the topic at the time and e resources available. So if the topic lends itself to group work ry to use grouping or if it's one that encourages experiment, I an so that it happens if possible**

**15** Can you share some advice for other pre-service teachers eparing to teach lower secondary science? What can pre-service achers do to motivate science students to learn at the lower

seconda
**because**

espondent 57 (R57)

**4** What teaching and learning strategies have you used to iotivate science students during your professional xperience placements? (Please specify) **Concept maps, harts, experiments**

**5** Can you choose one strategy that you provided in Question 4 nd describe the lesson/context in which you successfully used that rategy?
rade:7
opic: **Feeding relationships in a habitat**
me of day: morning or afternoon: **Morning**
esources available: **Charts, flow of energy worksheets, owerPoint presentation**
ow was the strategy used? **I used presentation to show feeding elationship between organisms and the chart to show how the ood chain works. The flow of energy worksheets were given to**

**used real life examples so the students were able to relate to the use to teach a p esson**

**ie students to complete.**

**Q6** Can you de
question 5 a su
**Q10** Can you te
All the stude

**Q11** For any gi
can you give m
NOT to be effe
professional ex
**If the topic is I**
**the activity. Sc**

**Q12** Can you te
was NOT effec
**styles and tha**
**Q14** Can you g
factors in quest

students to lea
**The type of st**

What teaching and learning strategies have you used to
ıotivate science students during your professional

**9** For any strategy you have used in the previous question, can ɔu give me an example of a time when you found that strategy to e effective in motivating science students to learn during your rofessional experience placements? (Please **specify) I provide**

**15** Can you share some advice for other pre-service teachers reparing to teach lower secondary science? What can pre-service eachers do to motivate science students to learn at the lower econdary level?

**now the type of students that you have and prepare the esson so all of them can be excited about learning science.**

**feedback to my students when they are completing activities which helps to motivate them to learn.**

espondent 58 (R58)

**4**

xperience placements? (Please specify) **I used story telling and made the concepts relate to their life Q10** Can you tell me why ɔu believe the strategy was effective at that time?

**he excitement**

What teaching and learning strategies have you used to
otivate science students during your professional

**Q5** Can you choose one strategy that you provided in Question 4 and describe the lesson/context in which you successfully used that

**Q11** For any

strategy? can you give me an example of a time when you found those strategies Gr

learn during your

Topic: **Blood vessels**

professional

Time of day: morning or afternoon: **Morning**

**Individual w**

Resources available: Video, Charts

How was the strategy used? **Showed the students the video and they were asked questions on the topic**

**Q12** Can you

was NOT effe

**Q14** Can you

**Q6** Can you describe what you believe made the lesson mentioned in

factors in

question 5 a successful one? **The questions were directed at making**

science stude

**them think about blood vessels in relation to themselves... eg do u think you would be alive if you had no blood vessels?**

**Like if I kno**

**students d**

**that will ma**

**9** For any strategy you have used in the previous question, can u give me an example of a time when you found that strategy to e effective in motivating science students to learn during your ofessional experience placements? (Please **specify) When**

**Q15** Can you

preparing to

teachers do

What teaching and learning strategies have you used to motivate ience students during your professional

el? **Ask yourself, why are you teaching and why do you nt the students to lean the subject. That reflection can lp u know how to motivate them**

espondent 59 (R59)

**4**

xperience placements? (Please specify) **I relate cience to what they know and that motivates them**

**5** Can you choose one strategy that you provided in Question 4 nd describe the lesson/context in which you successfully used that rategy?

rade:8

opic: **Food chains**

me of day: morning or afternoon: **Morning**

esources available: Video, Charts

ow was the strategy used? **i used the charts to help the tudents draw up concept maps and foodchains. The students ere shown videos of various types of foodchains**

Can you describe what you believe made the lesson mentioned question 5 a successful one**? I believe the fact that students d to use their imagination to create foodchains was helpful**

**since they w peers**

**Q9** For any give me an effective in experience **examples t the concep**

1. **Q10** Can y time? **Q**ue what they are

**Q11** For an question, ca those strate to learn dur specify) **I us students to**

**Q12** Can y was NOT

What teaching and learning strategies have you used to motivate
ience students during your professional

**14** Can you give me an example to illustrate how one or more
the factors in question 13 influenced the strategies you used
motivate science students to learn?
**would prob use a different strategy when teaching the year
and year 8 students.**

**5** Can you share some advice for other pre-service teachers
eparing to teach lower secondary science? What can pre-
rvice teachers do to motivate science students to learn at
lower secondary level? **Use what you can in and around
class to make students learn and also listen to the
vice from ur prac supervisor**

espondent 60 (R60)

**4**

xperience placements? (Please specify) **role play and
am jobs**

**5** Can you choose one strategy that you provided in Question 4
nd describe the lesson/context in which you successfully used that
rategy?
rade:10
opic: **questioning and predicting** Time of
ay: morning or afternoon: **Morning**

Resources
How was th
**scientists a
needed to
well as mac
science inv**

**Q6** Can you
question 5 a
**they were re
the internet**

**Q9** For any s
me an exam
motivating sc
placements?
**communica
each other,
their investi**
**Q10** Can you
**it's because**

What teaching and learning strategies have you used to motivate ience students during your professional

**4** Can you give me an example to illustrate how one or more of factors in question 13 influenced the strategies you used to otivate science students to learn?

**se alot of ICT and sometimes when the internet is down, I n't teach the way I want to nor motivate the students cause they love technology**

**5** Can you share some advice for other pre-service teachers eparing to teach lower secondary science? What can pre-rvice teachers do to motivate science students to learn at the wer secondary level?

**eck all your equipment before you begin teaching and involve students in the lesson**

espondent 61 (R61)

**4**

xperience placements? (Please specify) **I use alot of iscussion and I realised that students are motivated partake in the discussions when it they can onnect to it. I use alot of story telling as well**.

**Q5** Can you describe the Grade:8 Topic: **chem** day: morning

Resources a

How was the **chemical ch eg digestion students an allowed to c**

**Q6** Can you question 5 a **fact that stu water and c Also studer .**

**Q9** For any s give me an e effective in m professional **i give stude**

What teaching and learning strategies have you used to motivate
ience students during your professional

0 Can you tell me why you believe the strategy was effective at
it time**? the students feel good when i give them feedback on
eir work so i try doing it as much as i can. This makes them
otivated to learn from their errors and continue succeeding in
rticular KLAs**

**4** Can you give me an example to illustrate how one or more of
factors in question 13 influenced the strategies you used to
otivate science students to learn?
**ave learnt alot growing up and seeing what works for others
the classroom to motivate students**

**5** Can you share some advice for other pre-service teachers
eparing to teach lower secondary science? What can pre-service
achers do to motivate science students to learn at the lower
condary level? **If you praise a student then normally he/she
ll be keen on learning**

espondent 62 (R62)

**4** What teaching and learning strategies have you used to notivate science students during your professional xperience placements? (Please specify) Making them ugh

espondent 63 (R63)

**4** What teaching and learning strategies have you used to iotivate science students during your professional xperience placements? (Please specify) **experiments, ideo presentations, group work**

**5** Can you choose one strategy that you provided in Question 4 and escribe the lesson/context in which you successfully used that rategy?
rade:7
opic: **Classification of organisms**
me of day: morning or afternoon: **Morning**
esources available: **images of different organisms, video resentation, worksheet**
ow was the strategy used? **Students watch the video which shows range of organisms then form groups to organise and classify em.**

; Can you describe what you believe made the lesson mentioned in estion 5 a successful one**? The students were keen on learning out the similarities and difference between organisms based on e video presentation. We had a good discussion**

**!9** For any strategy you have used in the previous question, can ou give me an example of a time when you found that strategy

to be effec
professior
**students**
**the conce**
**what was**

**Q10** Can
time**?** The

**Q11** For a
can you g
NOT to be
professior
**some stu**
**activities**
**motivate**

**Q12** Can y
was NOT
**experime**

**Q14** Can y
factors in
science st

**ɔften observe other teachers and ask my peers what are some of e ways they motivate their students to learn. I also use the pst roups on social media to get ideas.**

**5** Can you share some advice for other pre-service teachers eparing to teach lower secondary science? What can pre-service achers do to motivate science students to learn at the lower condary level? **I would say, there are several resources ailable and as a pst you need to use all those resources to ake science interesting for students in lower secondary hool.**

espondent 64 (R64)

**4** What teaching and learning strategies have you used to motivate cience students during your professional experience placements? Please specify) **concept maps, individual worksheet, emonstrations**

**5** Can you choose one strategy that you provided in Question 4 nd describe the lesson/context in which you successfully used that rategy? Grade:8
opic: **Cells**
me of day: morning or afternoon: **Afternoon**
esources available **charts, microscope, slides, video** How was the rategy used? **Charts were used to show that all life is divided**

**into two c structure**

**Q6** Can yo question 5 **excited to**

**Q9** For ar give me a effective i professior **use every science i**

**Q10** Car time**? I b were be science**

**Q11** For can you NOT to b professio **I remem to be wa just a fe keep the**

**Q12** Can you tell me why you believe the strategy identified in question 11 was NOT effective? **limited resources (few microscopes)**

Respondent

**14** Can you give me an example to illustrate how one or more of the ctors in question 13 influenced the strategies you used to motivate cience students to learn?
**/hen the resources are limited I have to use a group approach to earning. The more resources you have each student will be able o participate in the lesson and class activities which motivates iem to learn.**
**5** Can you share some advice for other pre-service teachers eparing to teach lower secondary science? What can pre-service ichers do to motivate science students to learn at the lower condary level? Try and make sure that the resources are available the lesson being taught as this will determine the type of strategy u will use. When this is known you will be better able to plan a son that will motivate students to learn.

## espondent 66 (R66)

Skipped all qualitative questions

espondent 67 (R67)

**4** What teaching and learning strategies have you used to motivate
ience students during your professional experience placements?
'lease specify) **Webquests, Cahoots, grouping works**

**5** Can you choose one strategy that you provided in Question 4 and
escribe the lesson/context in which you successfully used that
rategy?
rade:
opic:
me of day: morning or afternoon: **Morning**
esources available **Lab**
ow was the strategy used? **We experimented on plant cells under
e microscope in pair**

 Can you describe what you believe made the lesson mentioned in
estion 5 a successful one**? The students love the lab**

**Q9** Fo
you gi
be effe
profes
**out de
mean
partic**
**Q10** C
time**?**

**Q14** Ca
factors
science
**My lec
we car**

What teaching and learning strategies have you used to motivate
cience students during your professional experience placements?

espondent 68 (R68)

**4**

'lease specify) **Funny memes, Discussion, experiments**

**5** Can you choose one strategy that you provided in Question 4 and
escribe the lesson/context in which you successfully used that
rategy?
rade:8
opic: Forms of Energy
me of day: morning or afternoon: **AM**
esources available **charts, Youtube**
ow was the strategy used? **I used flow diagrams and video to
how how energy changes from one form to another**

**Q10** Can you tell me why you believe the strategy was effective at that time**? students understood the concepts better when they were given examples**

; Can you describe what you believe made the lesson mentioned in
estion 5 a successful one**? relating energy to everyday life**
**!11** For any given strategy you have identified in the previous
uestion, can you give me an example of a time when you found
hose strategies NOT to be effective for motivating science students

to learn du
specify) Sc
they did

**Q12** Can y
was NOT e
**motivated**

**Q14** Can yo
factors in qu
science stu
**am better a**

Respondent

**Q4**

(Please sp

Q10 Can

/hat teaching and learning strategies have you used to motivate time science student

5 Can you choose one strategy that you provided in Question 4 and escribe the lesson/context in which you successfully used that rategy?

rade:7

ppic: The Water Cycle

me of day: morning or afternoon: **Morning**

esources available: **water, charts, video presentation** How was e strategy used? **We started by having a discussion about the nportance of water and then I used the video and charts to xplain the water cycle.**

Q11 For a can you g NOT to be profession **The strat are not to**

Q12 Can y was NOT **thing.**

; Can you describe what you believe made the lesson mentioned in estion 5 a successful one**? I believe it was because they were en on learning the different uses of water**

Q14 Can y factors in c science stu **considera**

9 For any strategy you have used in the previous question, can ou give me an example of a time when you found that strategy to e effective in motivating science students to learn during your rofessional experience placements? (Please **specify) I often use eal life examples which they can relate to, this is very ffective.**

**? Kids love to play with water so they were keen on learning nore about it.**

Q15 Can yo preparing to teachers do level? **I thir lessons to**

**Respond**

**Q4**

Q10 Can

/hat teaching and learning strategies have you used to motivate time science student

'lease specify) jigsaw, experiments

the studer

**5** Can you choose one strategy that you provided in Question 4 and
escribe the lesson/context in which you successfully used that
rategy?

rade: Topic: Types of
ergy

me of day: morning or afternoon: **afternoon**

esources available: **charts, video presentation How was the
rategy used? students formed groups and are given
fferent topics to research using the charts and then present
the groups**

**Q11** For a
can you g
NOT to be
professior
**students
work**.

**Q12** Can y
was NOT
**was not e**

6 Can you describe what you believe made the lesson mentioned in
estion 5 a successful one**? the students were excited to learn**

**Q14** Can y
factors in c
science stu
**informatio**

**9** For any strategy you have used in the previous question, can you
ve me an example of a time when you found that strategy to be
ffective in motivating science students to learn during your
rofessional experience placements? (Please **specify) When a
tudent is put in charge of gathering information for their groups
ney are keen on completing the tasks.**

**?**

**Q15** Can yo
to teach low
motivate sc
**use the pre
many reso**

Q10 Can

/hat teaching and learning strategies have you used to motivate time science student

**espondent 71 (R71)**

**4**

'lease specify) demonstrations, group work, individual assignments

**5** Can you choose one strategy that you provided in Question 4 and
escribe the lesson/context in which you successfully used that
rategy?
rade:8

opic: pH acids and bases

me of day: morning or afternoon: **afternoon**

esources available: **various acids and bases, litmus paper, charts**

ow was the strategy used? **the charts were used to identify the properties acids and bases and the litmus test was done for each to determine the tegory**

; Can you describe what you believe made the lesson mentioned in estion 5 a successful one**? the students were keen on seeing the sults of the demonstration.**

**9** For any strategy you have used in the previous question, can you ve me an example of a time when you found that strategy to be fective in motivating science students to learn during your ofessional experience placements? (Please **specify) Fieldwork. I**

**brought th**
**animals in**
**meaningfu**
**? The**

**Q11** For a
can you g
NOT to be
profession
**are some**
**own expe**

**Q12** Can y
was NOT

**Q14** Can y
factors in c
science stu
**help me w**

Q10 Can

/hat teaching and learning strategies have you used to motivate time science student

5 Can you share some advice for other pre-service teachers :paring to teach lower secondary science? What can pre-service ichers do to motivate science students to learn at the lower condary level**? Yes. They can always go back to when they were dents and use the strategies that helped to motivate them as science dents.**

Q6 Can you question 5 a **own**

Q9 For any give me an effective in experience **groups as mates**

2. **? t**

espondent 72 (R72)

**4**

'lease specify) **models, group work, worksheets**

**5** Can you choose one strategy that you provided in Question 4 and escribe the lesson/context in which you successfully used that rategy?

rade:9

)pic: **Conduction of heat in solids**

me of day: morning or afternoon: Morning

esources available: **metals to demonstrate heat conduction, orksheet**

ɔw was the strategy used? **after the lesson a demonstration was ɔne and the worksheets were used to apply the concepts**

**Q11** For a can you g NOT to be professio **When the them ind**

**Q10** Can

/hat teaching and learning strategies have you used to motivate time science student

**)12** Can you tell me why you believe the strategy identified in uestion 11 was NOT effective? **the type of experiment and the esources that are available to do them**

**14** Can you give me an example to illustrate how one or more of the ctors in question 13 influenced the strategies you used to motivate :ience students to learn**? The time available to teach these lessons etermines the strategy that I will use to motivate my students**

**5** Can you share some advice for other pre-service teachers eparing to teach lower secondary science? What can pre-service achers do to motivate science students to learn at the lower condary level**? I would say always know your students and ow which strategies can be used to ensure that they all derstand the lessons being taught.**

**Respondent 73 (R73)**

espondent 74 (R74)

4 What teaching and learning strategies have you used to motivate cience students during your professional experience placements? Please specify) **Group work, demonstrations, field work**

5 Can you choose one strategy that you provided in Question 4 and escribe the lesson/context in which you successfully used that rategy?
rade:7
opic: **The Ecosystem**
me of day: morning or afternoon: Morning
esources available: **Videos, charts, Work sheet** How was e strategy used? **Student watched the videos and ompleted the worksheets**

Can you describe what you believe made the lesson mentioned in estion 5 a successful one**? The students were keen on finding t their role in the ecosystems in their communities and how ey could help to protect them.**

9 For any strategy you have used in the previous question, can u give me an example of a time when you found that strategy be effective in motivating science students to learn during your

profession
**fieldwork**
**own obse**

**Q10** Can time**? bel to learn a**

**Q11** For a can you g NOT to b professio
**Some stu they do n to work v**

**Q12** Can y was NOT **results. W**

**Q14** Can y factors in c science stu **how to tea**

5 Can you share some advice for other pre-service teachers eparing to teach lower secondary science? What can pre-service achers do to motivate science students to learn at the lower condary level**? Always try to find the best resources that will t your students excited to learn about science.**

espondent 75 (R75)

**Q4** What teaching and learning strategies have you used to motivate science students during your professional experience placements?
(Please specify) **experiments, presentations**

**5** Can you choose one strategy that you provided in Question 4 and escribe the lesson/context in which you successfully used that rategy?
rade:8
opic: Acids and Bases
me of day: morning or afternoon: **Afternoon**
esources available: **sample of everyday household chemicals, mus paper**
ow was the strategy used? **Students were divided into groups to st regular household chemicals using litmus paper**

**6** Can you describe what you believe made the lesson mentioned in uestion 5 a successful one**? Everyone was able to share the**

**results of**

**Q9** For any give me ar effective in experience **strategy t peers and**

**.**

**Q10** Can y time**?. The**

**Q11** For a can you g NOT to be profession **Some stu and watc workshee**

**Q12** Can y was NOT e

4 Can you give me an example to illustrate how one or more of the ctors in question 13 influenced the strategies you used to motivate ence students to learn**? There are experiments that are ngerous and cannot be carried out in a classroom setting so eir are software available that will allow me to carry out these periments virtually. This use of technology can also motivate ience students**

**Q15** Can yo to teach low motivate sc **the resour lessons ar and engag**

ummary numbers for the We-based survey

In total there were 75 respondents:

There were 4 who did not qualify for the survey There were 15 respondents who answered only the **quantit** some/all of the qualitative questions and Qualitative sections of the survey There were **49 respondents** who (completed the survey) –Completion Rate of 65%

## Appendix M
## Examples of Coding Based on the Four Principles of Motivation

C

⇒ Connectedness; Relaying information that is culturally relevant / connects to student's background. ⇒ Con

M

⇒ Meaningfulness: showing how learning can bring value to student's lives / circumstance ⇒ M

⇒

Main themes Turner et al. 2011

Competence: Providing feedback, helping students & reflect on what they don't understand ⇒ Com

Belongingness: Teachers are caring; groupwork, peer — B

Autonomy: Teachers show an understanding of A students' interest, goals, needs and then connect them to school tasks; giving choice

Meaningful learning: Students value for learning. building on prior knowledge, providing opportunities for complex thinking: Discussion with peers & teachers ⇒ M

Date: 5th November 2019 Peer Supervisor:
Time: 11:54 – 12:43 Rear left side
Participant: 1P Observer:
Topic: Human Impacts on Ecosystems Rear right

Students came into class and were asked to sync their devices "Tablets" computers
Students seated in 4 groups of "15 students"
Topic was introduced with images – II and asked about school strike for climate: students answered.
T: by "a 16 year old: kids like you" C/R

Video of Greta Thunberg's speech – CT/V
Students focused on the video projected onto a white screen board.

Video was stopped: and students asked. Q
"What are we thinking?" student answered
"Does anyone have a response to that?"
S: I think the same as
"She is 16 – Teacher: — R
"Do you think we have cause for concern to worry? – T : Y/N.

Explicit

— DI

Stated objectives: 3 aspects of today's lesson
- Deforestation

Asked for definition – student provided.
anyone else to build on that? — M

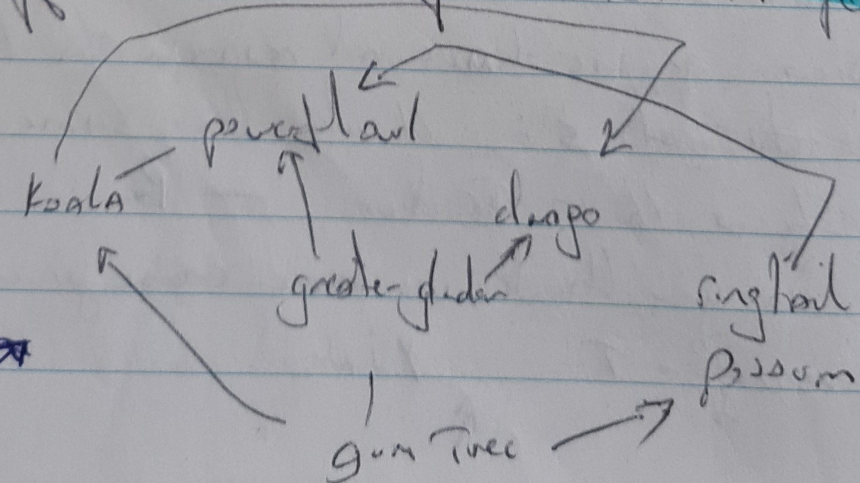
What happens with deforestation?
What happens to those animals that
live in those trees and depend on them for
food? — M.

Contextualised deforestation to Australia
in relation to football pitch: M
student googled size of pitch to get a
picture of gravity of deforestation 14400m²
ICT, R, M C

koalas get diseases "Chlamydia".

— E, R

Activity: on PC / tablet to highlight what
gets affected with deforestation in food
web



Explicit

— DI

Stated objectives: 3 aspects of today's lesson

– Deforestation

. Asked for Definition – student provided.

Anyone else to build on that? — M

– What happens with deforestation?

– What happens to those animals that live in those trees and depend on them for food? — M.

– Contextualize deforestation to Australia in relation to football pitch. M

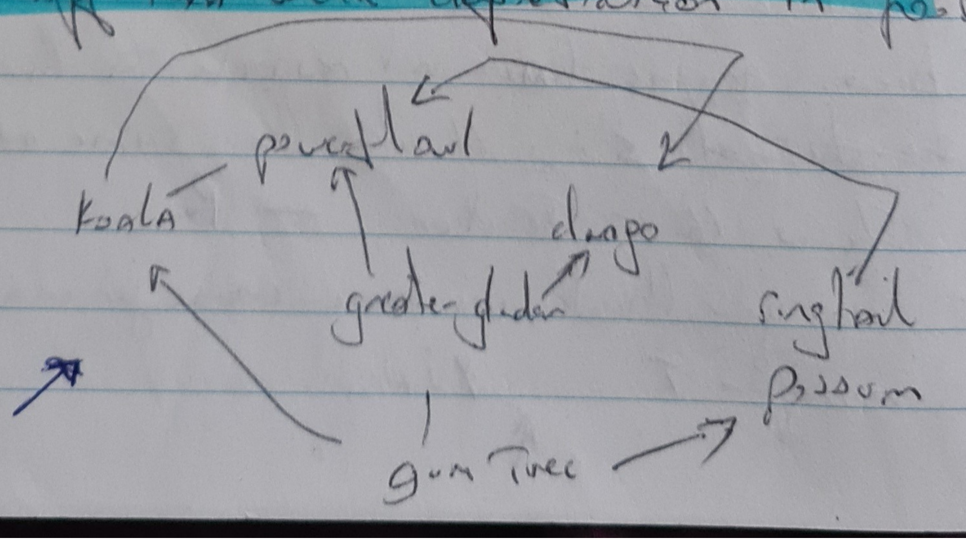
– Student googled size of pitch to get a picture of gravity of deforestation 14400 m²

ICT, R, M C

– Koalas get diseases 'Chlamydia'.

— E R

Activity: on PC / tablet to highlight what gets affected with deforestation in food web




map

scaffold

Teacher
- walked around to give scaffolding using the highlighter to do activity.

- Asked student from one group to help another group with Activity \ Peer scaffold.

- Gave students 2 minutes to highlight / finish. Activity: "what is affected in food web when trees are cut down?" - R

- Δ Gave students option to draw if they didn't want to highlight. Told them how to do so. Δ R

- Teacher stopped to demonstrate how to highlight Δ
- Supervising teacher assisted students also during activity. \ Δ.

- Asked if anyone heard about fires in Amazon and directed them to a youtube "Amazon forest fire: What it tells us about deforestation": 3:0
- Said this is an Example of fires around the world. \ R

— ICT

- while video was playing teacher moved around the class and helped 1 student with a computer issue.

- Video Ended.
"what do you think of the Amazon forest fires?"
student "Could be good"
students engaged in a debate. — Discuss
> student thought it was good and another thought not:
Teacher drew in the rest of the class to the debate; which other student contributed to — Q,f

Can you jot down animals from forest?
student said KOALA. teachable moment: KOALAS are ENDEMIC to AUSTRALIA OTHERS ARE KANGAROOS + EMUS
\ R,M

Students googled animals found in Amazon and listed them to the class.
Teachers used alot of NAME ~~calling~~ dropping to alert students to important things/concepts.

R

- Teacher moved on to human impacts & introduction of new species
- Asked about cane toads "
"students started talking about them"
⇒ Teacher gave a bit history of cane toads and students listened to story attentive
R, M

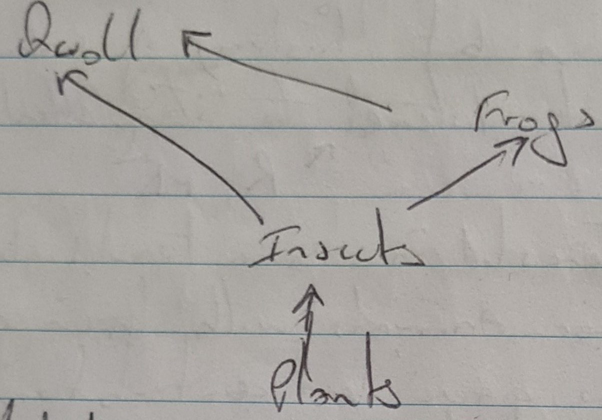
- Students were interested in cane toads bei[ng] able to kill other animals with their gl[ands]
Teacher in class gave a contribution
they can kill pets and are as cl[...]
~~Ax Hand~~ — R, M

- Activity:
look at video about cane toads & note down one fact. ICT, E

- students looked at video on their devices and screen to the front of the class. Raised their hands to share facts. IC[T]
- Teacher stimulated by asking que[stions]
Q

Activity 3

- Teacher asked to highlight what is affected in food web with Quoll by Cane Toads




ICT

students Googled Quoll to learn about them: "Miss is this a Quoll?"

- Teacher clarified misconceptions about Quoll

Student gave a fact on Cane toads

What are the two things we completed today?

Deforestation & Introduced species

Topic: Global Environment.
Date: 28 Nov.
Part: C.
Time: 9:55 -
Year: 10

Students came into the class while teacher set up computer.

"I'm actually super pumped up today we are going to look at cyclones today. I trust that you guys will be interested as well"

- Students were given work sheets and asked to write names to put in workbooks at the end of the class.

- Sets up PPT; and introduced the topic "does anyone remember the 2007 storm?"
Gives personal story about storm."
"students laughed."
Began explaining what a cyclone is

You may be able to grab an answer to the worksheet if you pay attention

- Continues to explain powerpoint while walks around and ask "has anyone been into a cyclone?"
  He gave a story about [illegible] in a cyclone.
  "Wasn't it hurting?" questions were asked by the students.

- Showed a pic of Australia and cyclones forming in QLD.

- Gave loads of explanation of the different contexts / definitions around the world for cyclones.

- Showed world map of where cyclones formed: stated conditions for formation of cyclones

- "Taking you guys right back to year 7. Convection currents: the experiment you did with the purple stuff in the beaker."

students started talking and smiling
and answering questions about labelling
a cyclone.

"Teacher labelled diagram on the board
with the help of the students"

"We all got that down?"

"Student came to front of the board to
write on the board label."

Turn over the worksheet:

"Told students what is expected to be
done"

Summary of cyclone formation.

- Explanations of every step

Everything in our lives, phones traffic
is straightened but weather we don't
we can't choose where it forms"

- Asked students to write steps down steps

Notes

from ppt. or board.

* Students asked Questions about cyclones merging.

— Personal

* Teacher gave personal story of QLD and Explained cyclone moving over land.

- "I'm Am going to be annoying and ask you to write that down [step 4] the more information the better".

St. protests weakly but write

* If we get time we can watch some tornado videos.

— Scaffold

(Teacher walks around and interacts with students to ensure they write the steps.)

"I'm so Excited I love cyclones" teacher told the students" — Enthusiasm

Showed a visual representation ~~and~~ of what was discussed.

* "We are going to watch a video now" (video)

Teacher tried ~~to~~ playing video on ALGLT g... we should be on now.

The ST: was helping..

Video about life of a cyclone was played.
· Teacher walks around the class while St. watch video.
T: "Allright pretty cool?" ] Discussion
St: Yea heaps
T: "Heaps cool."

T: Explaining: Do you remember back to monday when we were looking at isobars.
St: Gave response.

T: Does anyone know how many cat

What damage does winds of 300 k have:
Do you remember the cost coast bun. that was 120 k.
student stories
T: Teacher related to the students and then students gave their personal stories of wild weather. "We were surrounded by trees & thought our house was going to get crushed"
Teacher Gave interesting fact.
students were interested.
interesting fact

- students talked to each other about wild weather experiences.

\# Irma — # Michael.

- T: showed videos of different categories
  "Guys watch. It's the best part of the lesson I reckon"

Students were excited and talked while watching video "There's your flipped house"

"Will this be a strong one or a weak one."

St: weak" ~~we~~

- "why"

St: Because it ~~p~~assed over land" Good on"

"We wanna do a Quick recap:"

T: asked Questions about the lesson and then students answered "recall Questions"

T: What do we want? Do we wanna watch some Tornadoes?

St: ~~Yes~~ Yes.

- T: told students what to expect on Monday

T showed tornado videos

"thats cool thats really cool?" -sd.
students laughed.

T: Explained how tornadoes form to students who asked.

: Can you grab your work books and slide
" Your, eyeglone sheets in (Here
: "I hope you guys enjoyed that"

Class Ended.

Date: 8 November 2019 Y:

Time: 9:

Participant 2A

Topic: Making a wet mount. 10 students

I know we have a small class but we are going to get a practical done.

- Can any one guess what we are doing for the prac: "St: Microscope?

- You have been given microscope slides before, today you will be creating your own slides. You might have your own microscope - St: Yay!!

- We are going to write down ~~what~~ what we are going to do today.

T: proceeds to write methods on the board.

CAry

- Does anyone need paper or a pen?

- Teacher gives a student a sheet of paper.

- Students quietly took down methods

Teacher walked around to students and conversed.
"You can keep some" teacher said as student showed her a sample of -
"We can use it for the microscope"

- As students wrote the methods, the teacher brought in the microscopes and started cutting the onion "preparing them"

- When we look at an onion under a microscope we should draw what we see. What do we know a good scientific drawing has:
St: Label
T: "what else: " calls students by name.
St: water?"
Writes success criteria for drawings on the board.
Relates to when student comes back to drawing they need to know what it is so labelling is important.

Explain

teacher asked about magnification and showed how to calculate magnification. ~~Students~~ students answered the simple math.

- Teacher draws what she expects sts to draw.

"If you could come back around this area here, I'll go through how to make a wet mount."

* students gathered around the front table as teacher demonstrates how to make a wet mount: ✓ Demonstrator

* teacher explains how to handle a microscope and safety precautions around handling glass.
student: "we have done this before"

* Teacher continues to demonstrate: students asked questions and teacher explains how to get the thin layer of onion skin.

- Demonstrates how to use Methyl Blue and states that if it gets on your hand you will have blue hands all day.

~~After demonstration students~~
Teacher moved demonstration to the back of the class because of Dye being used. Not to stain desk.

- Students were then left to prepare their wet mounds with scaffolding.

- Some of you cannot do the slides with water and some of you with the methyl Blue

- Students worked in groups to prepare wet mounds.

St1: Miss I was successful
T: Awesome.

- St2: I am doing it solo.
T: You can do it solo

Students who completed and showed teacher were told:
"Beautiful ; Perfect"

At Mena's a disaster
T: "what happened?" And guided student to getting it done.

Students who were completed were sent to set up their own microscopes. The teacher passed around to ensure that it was set up properly and offer guidance on the magnification

Since there was not enough microscopes for everyone : students worked in peers and guided each other on how to see the slides under the microscope.

- Teacher gave students her already made slides and asked them to check to see whether there is a difference between theirs and hers:
- Students sounded excited at their final end.

were directed to drawing their observations in their note books

- Students who washed their hands asked for paper towels and were given them, before continuing onto their practical.

- The teacher kept checking in on a student who chose not to participate in the prac.

Students can be heard saying:
That looks like my TV screen

T: "That looks like neurons you got there"

St: "Miss can you turn the fan on?"
T: Sure

HEAT

Teacher turned on the ceiling fans and continue scaffolding the students working on their drawings and observations under the microscope.

Time

So we have 2 minutes to get our drawings done"

Teacher helped students with their magnification calculations in one group.

T: "what did it look like under the microscope?"
St: look like bricks.

Teacher viewed some drawings and asked "can you label that?"

If you finished with your studies pack up; put your Micro on the tray

countdown
3 2 1 countdown so students can pay attention and Pack up.

Sit down or else you won't get your exam back today.
Roll was taken and exams results were given to the students as they sat on their tables.

: the students watched their results and made comments such as "I failed"
students compared results on sci exam

~~Teacher asked students to~~

T "Do we have any Questions about the EXAM:
Do you think you could have done better
"A lot of you had trouble with the cells section", "we can go over it during the session"

T - "Do your cells section in the Her book that you are completing cause a lot of you had problems in that section"

- To start off today's lesson teacher reviewed success criteria.

"Those who have it good Job, those who don't Please complete it"

"teacher asked students what they saw under microscope and proceeded to draw sample of what they may have seen"

S: ~~B~~ell wall

Teacher asked about it

St: Makes it strong"

Bell. Class ended

End

**Appendix N**

**Interview Transcripts for All Participants**

**Paula and Cassandra's collated interviews**

**Semi-Structured Interviews**

**Duration: 45 minutes -1hr**

**Interview One of PSTs before their professional experience placements.**

**Goal: To find out about the pre-service teacher espouse theories about student motivation.**

**Participant #1:**

**Program: Master of Teaching Secondary**

**Year: 1st year**

*Theme One: How are espoused theories and theories -in-use of motivation are developing during their professional experience placements? (Main Research Question, RQ1, RQ4)*

1. Can you tell me about your experiences that led you to develop your own ideas about motivating your science students?

**From my own experience, I think. This is the first time that I'll be teaching this so that's why I am hesitating a bit. When I look at my own experience of being a student and also through the course of my career, I would say the things that motivate me the most are time visits and independence.My own learning I guess, so there's a sense of independence and ownership...The other really motivating factor in science was definitely doing the hands-on stuff. It seems to be stating the obvious but I think the more hands on you are the more of**

**an active participant you are in the learning process. So just consolidating the theory with the practice. So, I am not talking about teacher in training I am talking about my prospective students, not just relying on theory but relying on a combination of theory and practice. And that might be practice in terms of …… or it might be practice in terms of connecting it with your world outside the classroom or it might be going through the practice or problem solving. It does not always have to be a practical… I think there's a main theme… I am yet to work out how this will play out in the classroom obviously. My motivating factor was always when I was allowed to, when I was given the freedom to act on any ideas that I had**

**1. . So your given input and you are given the license to act on that**

**input. So respect and I reflect that on the students like you know they are going have stuff to contribute and I would like to acknowledge that and give then the freedom to act on it if possible.**

**I think also it might be a bit idealistic like, I am just here thinking of cases of students not being engaged or interested to start with so as to how I would motivate them, that would be an interesting situation to deal with I think.**

***2. Are there any other experiences that helped you develop your ideas for motivating science students? Can you explain that?***

**I've got a lot of opinions about things. I find it pretty complex. The other thing about motivating students, I think a big part of it is showing them the respect and I sort of like… what I mentioned previously about giving them credit for their ideas and giving them the freedom to act on those ideas. A big part of that is actually having respect for me. My**

**philosophy is that we are on an equal platform. The only thing that I've got that would be extra is experience as I am older but I don't view myself as I am on a higher ground or anything like that , I feel there is an equal platform and have something to give and the students have something. And that helps learning, not only between but also between the teacher and the student. I do have pretty strong ideas but I don't have in teaching specifically…I have not been able to put into practice but I am very much about an egalitarian view.**

**I believe that the students have got a lot to offer too.**

**Can you explain that?**

**I think I will make a good role model and I think I have a lot of content knowledge because I have got a lot of experience in science class. And then I've got real world science experiences. I have worked in a lot of labs and stuff like that so especially with students I can give them a context out of the classroom. In terms of how it would be to—potential careers, I could offer some sort of advice in that respect but also, I've got like a real-world view of science.**

*Are there any other experiences that led you to developing your ideas foir how to motivate students during your professional exp. Placement?*

3. Have you experienced anything during your studies that has led you to understanding how to motivate science students? Can you explain that?

A lot of things in the span of this course had specific things to motivate students.

The teachers and they probably do this, they use a lot of examples. I am sure they consciously do this, but they demonstrate a lot of strategies that I feel that gives really good ideas for how to execute strategies in the actual classroom. I had one teacher for a psychology subject and it was a fairly simple process but she would always start with questions and then during a show of hands just getting us involved and giving credit to what our prior knowledge is and also addressing the misconceptions and then she would engage us in whatever learning extra or a tutorial and she would ask questions. A similar teacher who is associated with this placement would demonstrate a lot of how to go about doing group activities. That's really helpful, he would do it over and over again and would show how to form into peer groups, groups by KLA. He has demonstrated really good group working in that sense. And then just a little specifities in bringing their own that may or may not be related to the content. It shows they're bringing their own personality their own interest and that might be subject specific or they may not ----At a point ot interest.. a narrative you may say.

**It's a lot of, I guess the teachers like I said earlier being a role model so obviously they are experts in the field of teaching so setting a role model for us and showing us how to go about doing things. Those are only a few instances there are probably even more but this is only my second semester. Not a huge/long way through the course.**

*Theme Two: Factors influencing how espoused theories are enacted during the professional experience placements (RQ1, RQ2, RQ3, RQ4)*

1. What strategies do you think you will use to motivate science students when you go out on your professional experience placement?

**I haven't thought a little bit about it that. I haven't prepared for these questions. I have met with my supervising teacher and I am aware of the units or work that will be carried out and alot of the stuff that I 've come up with is ... I think it's really important to promote student engagement by making learning material relevant. For example, where my supervising teacher is interesting is doing a unit on ecology, and she has already suggested the unit plan, but I think it's important to look at the surrounding environment and the ecology of the surrounding environment. I think just you can try but just the elements, so I think it's a really important one from the Quality teaching model. That one really stands out for me.**

**My two main things is the connectedness and the other one is you can't really move anywhere with the kids unless you know where they are currently, You really need to get an idea of what is their level of knowledge, their level of expertise, what's their current level of skill set to work from at least rather than just having a set requirement. Just finding out the varying abilities of the kids working from there and looking at connectedness. For example the school next to ours, I don't know if this is going to be possible but I was thinking it would be great to walk the road and visit the plant care Centre, the biotic and abiotic factors in that system and look at the very specific adaptations your vegetation, you have to deal with high acidity levels that kind of thing.**

**The other thing that I, and this is from my career, I really believe in is colleague**

**collaboration. So obviously I've got my supervising teacher who I will be relying on but for example I know that there is a plant care centre the lady that runs that plant care Centre is very very knowledgeable so actually it would be very good to get in touch with her because she works in the field. Get in touch with her in terms of native plants native animal species, that are in the local area. She is very very knowledgeable; I've had dealings with her before so just tapping into existing rather than making it up from scratch myself, I have been thinking of that as well.**

**The other thing that I mentioned before was that I want students to be the conductors of their learning because if you are actually an active participant and you are thinking better, so I can get them to set up experiments, looking at the changing abiotic factors , temperature water. I was thinking they can bring in seedlings, so this is something they're bringing in the classroom. Getting them to conduct the experiment, design the experiment that sort of thing, with guidance obviously. I have some ideas but I will have to see the relationship goes, I would really like to encourage them to contribute and have input and have a say. Even though I might set guidelines; this is what we need to move in, this is what we need to investigate, that kind of thing.**

2. How effective do you think those strategies will be? Why do you say that?

**It's really hard isn't it? At the moment I figured everything is a bit hypothetical. I can only come up with ideas because at the moment I've only got a communication open with my supervising teacher but I know that will change when I walk into the classroom because**

**everyone is going to have their own personality and just before I go to the classroom, you have to have patience first of all. I cant just jump in and say this is what I want, like I said I am dealing with students I can't just expect them to produce I have to work with either, have some kids that are able to run with it some not so much.**

**Also that issue with me being obviously a new person, I am perfectly understanding that I need to give it time but the only thing I can say at this point is the dealings I've had in my life and the dealings with teaching other people and with my own experience with students. I am just gauging it from there and trying to see how it will go in the classroom.**

3. Is there anything that influenced why you will choose those particular strategies to motivate science students during your professional experience placement? Can you explain that?

**I say it involves a lot of studying and talks. But the other thing would be my own experiences of enjoying group work and collaborative work and the interaction and the discussion.**

**I also think while you're in the classroom you may as well interact as much as you can because you can be at a disadvantage. Because the individual work will hopefully, obviously I will try to give the opportunity but a lot of it can be done as individual research**.

Can you explain that?

**In the classroom when you have a lot of people in one room it might actually be a god idea to take advantage of you all being in there together and actually interacting. Everything**

**goes hand in hand so I  am not just going to be doing or aiming to do all of one thing but I think  that interacting as much as you can and making positive experiences in the classroom  is the way to go rather than just having everyone sitting individually and doing their work when they can do that outside of the classroom. You cannot guarantee that they will go home and do individual work so obviously I would need to address things according to individual personalities as well.**

Is there any other thing that influenced why you will choose those particular strategies to motivate science students during your professional experience placement?

**It's probably stating the obvious but it's also the fact that's its supported by the research. In the research that I've had to do associated with the subjects I've been doing; all of these strategies have been supported by the research. Just seeing the effects of when science teachers…. I was there reading some papers where science teachers have a really collaborative environment of learning, were we walk around the playground and the grounds is an extension of the classroom it doesn't just stop at the front door. So that's just all collaboration, connectedness and all of those things that I mentioned.**

So you said research, was there any specific ones that stood out for you?

I wouldn't know the authors at the top of my head. I do have copies of them all. I included some papers of, something to do with ambitious science teachers.  The title is along that line and they looked at the work of some really…I think it was 3 or 4 teachers they looked at and what strategies, these were very effective teachers and what were their strategies  that they were using and they were just really.. one of the teachers was just really the learning does not stop at the front door you know we go out , we do things science is all around us which I absolutely believe in. Another teacher was like, all those displays she had in the classroom were actually the kids creation so things like class concept maps and class mind maps and just that whole process of industry and wanting to be carrying projects that they were doing was evidenced in these sort of posters and they were just like works in progress. Then there was another teacher and he would just keep rearranging the furniture; it's like now you're working in this kind of group, now you're working in that kind of group. Just a very dynamic space and I actually have seen it on my observation placement where especially with the really industrious teachers, the students, they already know very simple things, *they already know that's where the safety glasses are , put my safety glasses on, this is how I go about starting the experiment, I know when to put gloves on, I know when I need to go outside and do things*, so it's really self-regulated.

How do you think being on your professional experience placement will help you develop your ideas for how to motivate science students?

**I think this will be a very steep learning curve actually. Even though it's going to be a steep learning curve it's also going to be extremely informative. I think I will learn a lot and**

**particularly when you are dealing with kids and dealing with so many kids in one classroom situation, you always come away learning new things like okay this would work better for such and such, maybe this would work better for the whole classroom and it's a platform for me to try and test my ideas and my strategies to see if they are working in practice rather than just theorizing and putting it in the assignment. Actually seeing the ideas flow. I think that's really important by doing things on paper you are very limited. For example, we've had to put in a unit plan and lesson plans so I am really keen to get some ideas from there and take them into the classroom if I can and see did my school ideas actually work or not? and do I need to just change the whole thing?, do I need to modify a little bit here or there? I think the kids will be very honest in their feedback basically.**

Is there any other way that you think being on your professional experience placement will help you develop your ideas for how to motivate science students?

**Definitely, I think another big point is watching other teachers. Not only my supervising teacher but just even in 5 days of observation last semester and observing a whole day of classes and different KLAs, you learn so much, not only in terms of ideas but in terms of strategies, how you show respect to students, how you show sensitivity to students , how you stop situations from getting out of control. Just tapping in the experience of not only the supervising teacher but observing other teachers in action as well.**

Thank you very much. We have come to the end of the first interview

**<u>Participant 1P</u>**

**Duration: 33 Minutes**

**Interview Two of PST during their professional experience placements**

**Goal: To find out how PSTs are using their strategies to motivate science students (RQ1, RQ2. RQ3, RQ4)**

1. **First of all, how's it going?**

*It's going a lot better now. There's been a little bit of a rude shock to my system on the amount of work required when you're starting out. So, I'm just dealing with the dilemma of lesson planning, preparation all of that sort of thing. So it's not just the lesson plan, it's your resources, it's your ideas, it's what you're going to present in class. Even the overwhelming thing has been the whole thing about public speaking. I do not like public speaking. Why on earth did I choose to be a teacher? Cause I am passionate about science and I passionate about kids. So I love the kids and love the topic and I thought well, it's a match made in heaven, but it's a lot of work when you're starting out. That's been the challenge. And the other challenge is that all that work doesn't necessarily pan out in class. You could be putting in a night's effort into a lesson and it could be a fizzer, or you could be a fizzer and that the other dilemma of balancing between putting in the work, which I am cool with, I am cool with the hard work I've learnt that but it's also being switched on in class and having the energy. If you're flat and if you're tired and you take in that into your class your kids reflect that. I've learned this all from the prac experience.*

2. **Can you tell me about a science lesson when you felt that you really motivated the students?**

*I can say this across the board that when I finally figured out that I am not walking in with a whole bunch of information and dumping it on the kids, it's important for me to be knowledgeable but it is more important for me to extract the info out of them. That's the times when I finally realized that and actually executed that; that's when the kids were engaged, when I actually had them doing stuff.*

*I have to be honest with you Davis in the beginning it was like a uni presentation, what the lecturers were presenting to us, PowerPoint, and then my supervising teacher said what have you got the kids doing? What are they learning? It's like oh yea!!! I was just thinking about my preparation on myself and selfishly ignored my whole class of kids.*

*It works differently as you've evidenced today, so when you have high achieving students in a high year you can give them a lot more responsibility. Yes they need guidance, that's why* I gave them websites; we did a little bit of research last week and I noticed that they needed websites rather than just going to the abyss of Google. *I researched those websites, I gave them selected topics, honed them in because I knew there were time constraints, I knew I hadn't given them much time. So here's your information, you guys process it now. Here's your information, you guys discuss it now. The discussion seemed, I was overwhelmed cause it seemed out of control, but it was actually, their output when they shared with the class, they were showing integration of information really good, and really good information processing.*

*With the other class, they need tactile hands on. There able to be high order thinkers just as capably but the route is a little be different. So, they are one-year level down and they are like a lower achieving; year 8.*

**b. Can you tell me of a lesson where you felt like you did not motivate the students?**

*Yes, I have had some stinkers. There was one last week, with the year 8 class and I had another big stinker with them as well. It sounds funny when I say that, I'd put in the preparation, but I obviously not taken into mind how they would receive things, so I walked in, you know where I went wrong? On the recap, did you noticed I just pushed on through. -----has been saying that to me, my supervising teacher, I feel sorry for her now, she has been saying to me for weeks "don't rehash, move on, so the exact word of 2 minutes move on, if it's not working in 2 minutes move on. It's sad that it took so long for the pin to drop. That's what I didn't get in those lessons, that didn't work, I didn't realize that, I kept pushing my program , my agenda my plan and I could see they were like visibly not engaged and I am like no start to finish, this is what I have sorted out, I am rigid, I am not going to move, this is what I am going to do. The lack of flexibility could have been a confidence issue but or lack of experience, however we justify it but lets leave that aside.*

*Today, even yesterday I could see the tremor in the room when they disengaged with the Greta Thunberg video, why didn't I stop it there? I needed to come and stop it there. Today, my plan was to play that video right up till 3 minutes and 54 s, I saw them one minute earlier like ahhhh. When I saw that tremor, it took me 2-3 seconds to make the decision, this is going to pause. *They have gotten what they are going to get, stop now*.*

3. What main strategies have you been using to motivate science students?

*I have to be honest with you, I never sat down and said this is what I am going to do, but I've always thought of how to get their interest. My key thing is being relevant. You will notice, I try to pick up things, so as soon as I mentioned Mount --------local examples even from day one of ecosystems, here's a picture of Lake---------- here's a picture of ----------beach, really really simple stuff but it's relevant. Even yesterday, they were happy to do with the effect, you know endangered species in Australia, they were saying kangaroos and Emus, there was a guy there I haven't gotten boo out of in weeks and he was looking up what a quoll was. He actually looked up what a quail was but hey he was looking it up and that was the most I've gotten out of that kid. That was actually a really amazing moment for me because that guy is not interested, just* *not interested and I am like but you are interested, kind of in your own way. It's measuring the victories with each kid. I've been looking for relevance, that's one thing.*

*One of our lecturers always says look for a hook. I was doing a lot of hook seeking, I still need to broaden my horizons, I don't think I have succeeded on the hook thing.*

*When you say a hook can you explain that?*

*Just something that gets them interested. This lecturer did a really cool thing when we were doing microorganisms, she dropped fluffy toys of, you know viruses and streptococcus and that. It may not work for this class but just, that's only an example, that worked for us but it could be something completely different. That I don't think I have addressed as well but then,*

*for one of my groups the year 8s the hands on-practical works. That mould lesson I had, that's why I did bread, I am like lets grow microorganisms, let's do this. They get involved and they process a lot of things. They were saying, did you hear their observations? —green and pink, I didn't even tell them to do that. I am like fill in the blanks. Miss had them at a lower level and they were like *no miss, it's pink it's green, it stinks*. "I had this mould growing sandwich for 3 months" that is a kid that you have to extract information out of usually, but he was offering me information. He had a smile on his face. Victory man Victory! So those guys, I actually agree with them because I love practicals as a scientist, I love practicals.*

*The other guys[y9] they loved discussion. They have got so much to offer and listen to and you throw them a guided bone but with some minimal scaffolding not much as you could see what they produced. I'll go back a see that PowerPoint and I will be impressed. They are not my kids and I am proud of them so anyway these are my things; Relevance, practical and discussion.* ***Is there any other strategy****?*

*It should be more shouldn't it? The other one is, this sounds really little but it's knowing their names, is a big one. It's a really big one, even today in that class of 30, I got a couple of their names mixed up, I think I am getting there, I think I am above the 25/30 mark, that was one of the first lessons when I marked the roll in class without going so and so –here—There was some balancing going on in there and I knew names.*

***What does the names do? How would knowing their names motivate students?***

*Because it shows that miss cares about me. Like if someone comes to me and goes "hey mate" I can pick up from a mile away you don't even know my name or you are too scared to say my* *name out. I would rather you fail at saying my difficult name. It's a personal acknowledgement that they actually mean something. That's what I've got to say.*

*The other one is am still failing on is the questioning technique is so important. I am still at the point where I am like*

*"hey guys do you think anything about this?" but the more you make them specific they run with that a lot better. I need to work on my questioning skills, that's a really key point. In fact that lesson with year 8 started well today because I had an experienced teacher say why don't you just put in that question?Thats the extent of her advice but that lesson started properly because of that important advice. They weren't even my questions.*

4. **On a scale of 1-10 with 10 being the highest rating, how would you rate the effectiveness of strategies you have mentioned? Why would you give that score?**

   *Names: definitely like 7/8. I don't know. It's a hard question but maybe even more.*

   *Relevance: I am inclined to put at the same because the key example was the deforestation like in Australia, yea cool, we are interested. Amazon, I lost them, didn't even give them a map. I had 2 girls out of a class of 17 actually tell me animals. That did not work that was not relevant.*

   *Practical: I feel that it's pretty important for that particular cohort to have at least one a week. You could see the effectiveness. If those guys, weren't looking at bread that's not even a practical, if they weren't doing observations and if they weren't putting water in seed and stuff like that, if they weren't doing that how would that lesson have gone? I would maybe give it a 10.*

   *Maybe they're all 10. If I didn't know a single name in any of those classes, hey you hey guys, It's probably a 9/8.*

   *The relevance varies because, so I have got a more worldly-wise year 9 class than I do in year 8, so highly important for the year 8, it depends. They are not as aware of general, just their awareness and perspectives is not as deep as, were looking at a high year level and we are also looking at a top class. This is a key difference. But you can, when I spoke to these guys, year 9 about the amazon last week because it's both ecology; that was a pumping lesson and that wasn't because of me, that was pumping because of them-that's why I wanted one of the really bright kids to share because he's got some, he has those pennies fold together in this beautiful way.*

   *Discussion: Again, there is a variation between the two groups, it's up on an 8/ for the year 9 group and then the year 8 group, I don't know about the discussion with them. I* *don't know how they would go with discussion with each other, but they do like bouncing off the teacher and I have noticed that looking at my supervising teacher. So, discussion is important for them but it's less autonomous, more guided by the teacher. But then having said that I loved the discussion, I don't think yesterday was a great lesson but I loved the discussion the two boys were having; one was like yea yea get rid of the trees, we've got houses that's a good thing, [other boy] no but …… And they were bouncing off each other, I didn't even wana shut that down. That was for me a little bit of rare occasion having seen something like that. It's a bit different in the year nine class.*

*Questioning: That's very important, I got told I get to be a bit like a sage on the stage, where you just stand at the front, and I picked myself up. Now I can look at myself from the outside a little bit better after a few weeks. But why didn't you just tell them, they know so much* or they can read ahead or whatever you saw the system in place. The reading ahead isn't too bad because they're also processing the information, they are not just blurting it out. I 'have done the stand at the front do the presentation and they just look at you. It does not work. That's not teaching anyway. That one I've got to work on, and that one is probably a 10 because I have actually seen; you have got to see this supervising teacher in action, the way she asks those questions, it is just beautiful toi watch. It is just so elementary as well. It should be simple but why isn't it. The two key things I noticed about her was the questioning and the relevance. Her narrative is always relevant, it's like and "then you do this… and then you do that" Her narrative is like putting herself in the shoes of those kids. It really works for that year 8 class.*

*Hook: The hook has failed. I would put it down to a 4/5 because I think that I could see myself just relying on the hook and then feeling like oh the job is done. Bu the job is not done. You actually need all those other things happening. The hook can actually, you can take it or leave it to be honest because anyway if you are doing all of the other stuff it could be like a so-called hook anyway. I don't think the hook is as much of a thing.*

5. **Are the motivation strategies you are using now different from the ideas you perceived before our professional experience placement? Can you explain that?**

***Yea the are different.*** *Because I am going to read. I did have to do a classroom management position statement and I had this really weird idea that we are going to create our learning together and just thinking you could come in with sort of a vagueness and get through and just build it together in that moment. But I have actually realized the key thing is to do heaps of preparation and have an idea of what you need them to learn, but then make it seem in class, I don't need to dish out the information to you guys, I need to get you started, get you guided, but then have them fully contributing. I realized there's a lot of preparation and guidance required. So, it's got to look like you are not controlling the class. That's what I'm thinking. Whereas my starting thing was a lot more vague, I have realized that…it didn't really work out in the first week for me. It was just* *too vague. There was too much vagueness. I had this thing in my mind that there's a constructivist approach to learning, we would construct our learning and I was lost in some sort of theory and maybe not even understanding what that theory meant anyway.*

*Even though I had those ideas what I was executing in class was just dishing out the information and then you guys just sit there and listen. But now I realized you've actually got to do a whole lot of prep work and you've got to have the ability and you have to provide complete guidance, but you have to get it out of them; that's what I'm learning. That how they learn and that's how they're interested in learning. If they're doing it… it's as simple as that.*

6. **Can you describe a lesson where you successfully used a strategy/strategy to motivate science students?**
   **What year level was the lesson taught at? What topic was being taught?**
   **What time of day was it?**
   **What strategy/strategies were they and how did you use those?**
   **Why do you think using that strategy/those strategies were successful?**

*I have not even noticed the time of day..I am only noticing this now actually. It's a big one. The kids are making me notice that actually, cause like they come in all hot and flustered after lunch and stuff like that and then they try and take me for a ride. They come up straight off a break=miss I need to go to the toilet first time I realized you just came off a break, or you're just going into a break you can go in 5 minutes. I am not going to say bye bye to you for the next 20 mins.*

*The biggest one I have been able to use and be successful at was the relevance*

*The relevance was a big one with year 8*

*Topic: I have used relevance all along the way. I have always got local examples*

*Time of Day: I know I started out using Lake -----images and even today Mount ------, The time of day really favoured me today because you were still in that morning block and then it's like uhh the end is in sight, it's not like uhhh I've got to go to another class. But they really pleased me today how they were interested with that topic, they really. That's all it took; it was my husband who mentioned it. He is like, he is that kind of guy that's like knowledgeable and I was like uhhhh ---I am failing and he goes you need to stop being negative. And he goes "have you seen this great book by -------, he is a researcher from ……Uni.. and he goes that's mount …….that's what's there that's what they did… tell them is mosaic =, tell them it's periodic, they didn't just flatten the landscape, they were doing spots and then hop hop hop the kangaroos go into the bushes and then they come out they graze and they go aww beautiful, then they get hunted." So yea relevance is pretty key.*

*Strategy was successful because they could relate to it.*

7. **Can you describe a lesson when you used a strategy or some strategies to motivate science students unsuccessfully?**
   **Can you explain why you thought using this strategy or those strategies did not work at the time?**

*Yea heaps. So, my food web really failed. I am going to be traumatised by this.*

*I should look back at this because I've got all my critical reflections. I got this whole class food web, who tugs who gets pulled so it failed. That was a key time of later in the day on a Thursday with year 8. Actually, in prac it's a pretty difficult exercise to coordinate. You have seen those kids like coordinating and I stubbornly push with that activity even if I was feeling really down for whatever reason and that showed in the class. My own lack of engagement in the class showed and the activity did not execute well. It was lacking clarity; it was lacking relevance. For an activity like that you need a super-duper level of organization and explanation and instruction.*

*So that's another one is clarity instruction as a strategy. Because you would have noticed that even today that I was actually failed on that. I had people still asking me "where's the PowerPoint miss" and I was like I did just wana put my head in my hands and cry right now because oh my goodness I said websites, I said you will be contributing, look at this collaborative PowerPoint, "is it a collaborative page miss?" no it is a collaborative ppt.. this is what miss is able to do, this is what she has done.*

**When you say clear instructions what do you mean?**

*Completely outlining what I want out of them. Everything they need for the task while they are not talking before they go discuss discuss discuss.*

8. **How has the guidance from you cooperating teacher and science education subject educators helped you in motivating science students?**

*Really important, so they have provided me with a lot of feedback. I've heard a lot of you didn't have them. I've heard from my Tertiary supervisor; I had a little demonstration at the front, and she is like I didn't even understand the demonstration. I was like oh my God*

*I use a lot of demonstrations—I forgot to say that. I do a lot of demonstrations. It only works for the front 2 rows. So it was such an easy task I could have had every single bench doing it. I thought it was good lesson but then she was like no, what about the second half of the class? You have a class of 30 people, not 15.*

*The guidance has been pretty good. My supervising teacher is very very busy but she is so accessible and I feel very sorry for her.*

**Duration: 35 mins 40 seconds**

**Programme: Master of Teaching Secondary science.**

**Interview Three of PSTs after their professional experience placements**

**Goal: To find out whether the pre-service teachers' perceptions about student motivation before their professional experience placements changed during their professional experience placements (RQ1, RQ2, Main research question)**

1. **Is it possible to remind me of some of the strategies you used to motivate science students during your prac?**

*The strategies varied. Now that I have a better knowledge of the groups that I faced, I had with the bottom year 8, I am actually thinking that narrative worked really well with them. So I am going to be talking in quality teaching model terms. With them narrative and connectedness worked really well with them and the evidence for that was on my last lesson with them we were talking about natural disasters and how affect ecosystems and in a lesson that wasn't overly prepared for I had so much input across the board from those kids. They had so many stories because I asked them the question "what is your first-hand experience", we went through fire, we went through drought and we went through flood. They had a lot of input and I had input from kids that don't normally have input as well. So that's narrative.*

*The connectedness, the evidence of that was I had a lesson and you were actually present in that lesson, was when I was doing the human impacts and I went while I was doing all the Australian examples, they were actually really interested. I mentioned to you the quoll, those kids like mistakingly typed in quail and they got it wrong but those kids do not normally engage in the lesson at all, and he actually influenced his friend to not be very interested but the fact that he even did that was like a small victory or even a large victory. And then when I went into the Amazon, the connectedness got lost and I only had out of a whole class of 18 kids, there might have been 16 present that day. There were only two girls that actually engaged with the activity to do with the amazon, neither of the kids were engaged and they were actually building upon talking about how Kolas are affected by deforestation. They were interested in the quoll because that's an Australian example, they were interested. They were mentioning kangaroos and Emus. So, they are the two factors.*

*Then the high functioning class in year 9, I found discussion works really well with them and it needs to be scaffolded. You need to give them direction obviously, that's the teachers responsibility, that they can actually run with it and then have their own very own topic scaffolding themselves. You would have seen that first hand in that lesson where a kid got something wrong about affecting population and everyone jumped in in a really positive way but there was an impromptu discussion and they were trying to clarify the point and the kid was* *talking it perfectly well; there was no antagonism at all, so that was really really good. Also when we had a group vs group when ----suggested to do a for and against, that worked really well and even though I was uncomfortable being inexperienced with the volume levels, they were really into that session and I could actually hear from walking around it was all on topic.*

***Were there3 any other strategies that you used?***

*Let's go back to the lower year 8, they loved to mix it up and they are very tactile, so they like to have hands on practical activities. They respond really really well to that.*

*The discussion definitely for y9. It works really really well for year9*

**2. Can you describe a lesson where you successfully used a strategy or some strategies to motivate science students?**

**What year level was the lesson taught at?**

**What topic was being taught?**
**What time of day was it?**
**What strategy/strategies were they and how did you use those strategy/strategies to motivate students to learn?**
**Why do you think using that strategy/those strategies were successful?**

*The narrative. They actually in that lesson it was interesting where the narrative plays a strong part of the lesson. But it was directly connected to the topic but the kids actually were able to bring up the lesson flows. They were actually able to build through their own narrative that this leads to this and they were building connections on ecosystems and loss of habitat and all those effects or as a result of the narrative.*

*It was late morning; it might have been an 11:45 class. They were really really good.*

*That was year 8, very responsive to narrative and connectedness. The other class being a year level higher very responsive to discussion.*

***Why do you think they were more responsive to discussion?***

*They are bright kids that have a lot to contribute, so rather than just sitting there and taking it in, which they will do, they are a very good class, if you have that expectation, they will do that. I did do, it was very interesting because I had one lesson where there was lots of discussion, lots of group work lots of group against group and then that was followed by a very structured lesson where it was to do with the indigenous practices and now I expect you to watch this video and* *process information, I expect you to look at this passage and highlight and make contributions. They were so quiet in that classroom, very very different, just a very well managed group. But discussion I think helps with their participation and their enthusiasm in the lesson potentially. It just seems like a more uniformed involvement, it gives you the opportunity, because they are quite bright and able to bounce off each other.*

3. **Was there anything that influenced why you chose those particular strategies to motivate science students? Can you explain that?**

*Getting to know them. As I got to know them, the narrative with the year 8 was something that I saw during observations, my supervising teacher actually utilizes it and uses it really effectively and just really well managed a listening class that wanted to have their say as well. So just as a result of watching a teacher that is effective and knows the class well, but also as I had the chance to get to know them, I could actually fell it first-hand. For example, I had with year 8 one lesson that had gone quite poorly and then I had to step up and do classroom management which was unfortunate but it was also the way. It was my mistake in the way I had conducted the lesson. The next lesson which was a double lesson I focused on hands on activities, it was kind of like a make-up but it was also planned.*

**What sort of hands on activities did you do?**

*In one session we did growing micro-organisms, exactly topic related so how we going to view microorganisms and they understood everything, that we wouldn't see it straight away, the colonies build up over time, then you start to see them, but you won't be able to see one single microorganism, you need a microscope. We actually did a little bit of microscope viewing as well, and the whole objective of that lesson was rather than jumping straight into the theory of why microorganisms are good or why they are bad, to do it first hand, so when food rots or mould grows on bread that can be a bad thing but then there is also all these foods like yoghurt and bread and yeast and everything that we actually are used to, it's like a positive side and then linking that to decomposers in the ecosystem, how they do nutrient recycling and everything.*

**How did they respond to that?**

*They responded really well to the practical activities and then in one of the lessons where you were present you would have noticed that I tried to get them really scaffolded instructions because with this group I just don't know when I am over guarding them or under guarding them. Because I didn't want too much time to be spent on the activity, I gave them a very scaffolded observation but you can see quite a few of them, at least 3 or 4 kids really extended on those observations. That was narrative*

***Was there anything else that influenced the strategies you used****?*

*My own failures. Obviously, I know about those strategies from the theory. We have done assignments and the whole literature and you look at the teaching strategies that are possible to use. So I was aware of the panel of teaching strategies from theoretical assignments and looking at stuff in class at uni. But then in the actual world, like I had certain ideas but you still have to modify according to what works with a particular group of kids with a particular teacher. Therefore, I was looking at what was the teacher doing; she is doing the job well, why is it working for her? maybe because she is experienced, and maybe she knows the kids. In my hands I am a completely different experienced and I am like, well I have to go through the journey of getting to know the kids and then low and behold oh, her strategies, I was almost without even realizing that they actually worked. So, there is a reason why she would mix it up, there is a reason why she would use a variety of strategies, she would use hands on, she would use narrative she would get them to do a little bit within their capabilities. In the year 9 class because they are really bright well managed group, there's a reason why you can a one note presentation, you can have them sit there with their devices because you know…. Even I noticed this, even when they do google searches, its actually related to the lesson, and I actually felt really proud, I was like oh, you're interested enough to now do a googles search to build upon what you're being told and they maybe come back to contribute.*

4. **Can you describe a lesson when you used a strategy or some strategies to motivate science students unsuccessfully?**

Quite early on with both year 8 and year 9, I was like, without even doing or even getting to know them, almost the second or third lesson in, I can remember I took year 9 out for a field trip and, we are going to look at abiotic and biotic factors and in that I didn't do any safety sort of features, I just gave them the paper. The lesson was well prepared, but I just gave them the paper and just said list biotic abiotic sop sunlight temperature, water and they you know there's a tree, there is a this and there's a that, but I didn't actually engage them any further. Even with a really good group I had a couple of boys run off to interrupt another class so the management was an issue, so I did that too early.

Even with year 8, I tried to do this fantastic foodweb, where I link you all up, I had those food chains constructed, so really well prepared. and they you knw.. the dingo dies off so you tug and see who's affected…They did not get that, it did not work, it did not coordinate well.

**Why didn't those coordinate well?**

*Because in both cases there was not enough time and effort put into the lead up explanation. So, it needed to be set up, why are we actually doing this and this is what I am looking to have achieved. Burt it was more of a jump straight in, do the activity because its interactive, it will work for itself. They were both fairly good activities but they needed much more explanation beforehand.*

***Those lessons that you mentioned, what time of day was it when you had them?***

*The year 8 was an afternoon. it was a Thursday. That's like Thursday of a week with a brandnew teacher.*

*The year 9 lesson. They were pretty good considering… but that was a lack of me being present in that moment. So, I could've actually quite easily said guys you need to come together. All you have to do is like say –aww let's look at this tree here, it's completely dying and I want you to think about this is a biotic factor, but why is its health compromised? What are the abiotic factors? Is it sitting in too much sun? is it getting not enough water? did the groundsman put some poison around there because there are weeds all around it. Think about these things. That one example would have been good... look along here…now think, I want you to think, I've told you what I want to think about, look around. Why is this plant over here unhealthy? Is it in direct sun what's going on?*

So, I think the guidance was lacking in that situation

4. **How has being on your professional experience placement helped you understand how to motivate science students?**

*It's been huge. Huge learning curve but I think a lot of the thing about motivation, and I was going wrong was where I was preparing my lesson and doing the information dump. So, I waking a huge motivation mistake. I started to realize as my placement progressed, I need to stop giving information even though I know all the information and start making them offer it to me. I made the mistake in my last lesson again, I gave them too much information, I realized that, but I would start to get rid of all the information and either convert it into a visual or turn it into a question. *Information on the lesson plans and what they receive**

*Its like ask them and whatever works for each group, narrative might help to build up information sharing and then obviously I am there to guide and confirm or affirm or whatever. In another group it might help to.. with them you can ask questions and they're really good ay=t giving you really good answers so they can enter stuff in there or discussion really helps with them.*

5. **How did your initial beliefs about motivating science students compare with your motivational beliefs during and after your professional experience placements?**

   **During prac beliefs comparison to prior beliefs**

*There wouldn't be a huge difference in the beliefs during. Even in the during phase I started to realize what actually is going on. The before I believe there would have been a complete absence of classroom management and getting to know the kids. That wouldn't even have been there. But*

*now I would say that one for the key things is get to know the kids and build bonds with them, even if it's like knowing their names, personal acknowledgement, acknowledging their contributions. Not everyone is going to give you the spot-on contributions you're looking for but you need to alter that for each kid. For example the kid that looked up the quail, it doesn't sound impressive at all but I think its impressive for that kid in my classroom because that kid basically has not said much and then following that lesson he contribute to the narrative, he said he had cows on his farm that are dying due to the drought. He actually had a lot to contribute. It actually made me understand when he put in that narrative, it made me understand a lot of the other things he was talking about beforehand.*
*I had a lot of ideas about the ideal classroom and the ideal strategies and how I should prepare material, before the professional experience placement, but that's 50%or less that 50% of the equation, but the other part is there is no point if you don't actually bother to know your kids or if you don't make them do anything. I was making in my pressure situation of placement, I was making a lot of mistakes of preparing, dumping the information and not making them do anything. The question is what are they learning what are they doing? Or I am going to be focusing a lot on; yea I need to prepare my content, there is no doubt, but I am going to be thinking a lot about what am I going to make the kids do and what are they learning. As I have shown you, I am going to modify my strategies according to the class. I don't think I can apply the strategy of discussion that really works with my year 9 class. I don't think I can necessarily use that with year 8. In moderation yes but it's a more dominant strategy that works with the year 9 class. The same applies to the narrative; the narrative works well the year 8 class but I couldn't make that a key strategy in the year 9 class. And that's about knowing the kids and what works for them as individuals and as a group.*

*I was more self-focused, I was more like what do I have to do? Then I realized it's not just about what I want.. off course I have to do a lot but I also have to get to know my kids. I was really really focused on .. ok this is a uni assignment, I need to get this done, I need to get this done, my presentations done, my worksheets done but what's the point. I had like fill in the blanks worksheets for a high year 9 group. that doesn't work. they just look at it and go ----I had bits of paper everywhere. So when I go into next placement, I am going to actually try and follow what the existing teacher is doing. In all likely hood they know what they are doing, they've worked all year or whatever to try to follow them a bit more rather than changing the whole thing for the kids and for everything, I am going to try and follow those strategies more and then maybe I can add on my own ideas to that. I need to make what's in place the core, follow that, cause as soon as I change to one note it just worked, cause that's what they're used to. Like low and behold I was using narrative in the end with year 8, low and behold I was using discussion in the end with year 9 and these were exactly the things that I just became so ok with. maybe I was just set in my habits of being a uni student or whatever but these are effective teachers. They are doing things that work for a reason.*

6. **Which motivation strategy did you think was the most effective one for motivating science students during your professional experience placements? Can you explain what made it effective?**

*The thing that worked best for both groups was a strategy that gets them involved What gets y9 involved, I found that asking them questions gets them involved and I found that linking those questions.. because often I would just shut down a lesson and not mention it again, but I found if I made links with the previous lesson or lessons and having those questions form a link, its just a very simple thing to do.. very direct questions and also the nature of the questions, the open ended questions.. What do people think about ecosystems? I am hoping I didn't ask a question like that but I was asking b=very open questions but if you ask a very specific question, they can actually give a lot back, so the nature of the question really matters. I would say questioning and discussion worked with them. With the other group I would say the overriding thing is the handson activities but well organized. They are they bottom year 8, that's the key thing vs they upper year 9. So with them what worked was also narrative, but connected narrative you building a narrative and your building the narrative, connectedness, so local real world examples and the hands on. Taking the responsibility of making sure you have all of those. I think I have listed 5 strategies there, making sure those 5 strategies are on topic. So it's my job to make sure that the questions are on topic and the nature of the questions are topic specific rather than what do you think about….. can someone tell me……. The guidance is also needed, so when I noticed in year 9, and I think I did that on the spot, I said oh guys, lets mix it up a bit instead of making it boring; half of the class is only looking at factors, that cause a reduction in population and half of the class is only looking at the other factors. It makes it a little more interesting.*

**Least effective**

*Exactly the same one was the least effective. So, questions were least effective when they were open ended.*
*Hands on activities were least effective when they were poorly guided, and you are not actually showing how it should be done. So, examples really helped with both groups, this is how I want you to do this. So, it needs to have a bit of teacher modeling, teacher specific instructions or actual demonstration.*

*So exactly the same techniques actually fell apart when they weren't well structured.*

**Is there any advice you would give PSTs?**

*Listen to your supervising teacher. I have some really specific ones. I'd say if you can get to know the names of people that would be great. I didn't really understand the significance of that but when you have a name or even when you mix up a name they even appreciate that; oh sorry ---your actually ----, You know even that when you even made an effort helps because they get it. I will admit in that class of 300 there were 2 girls I could not figure out… So know your names, listen to your supervising teacher, follow the existing structure unless there is a very small likelihood things are not good as they are, but in all likelihood your supervising teacher has taken you one because they know what they are doing with their kids and they know what they*

*are doing with you as well. So I would say listen to your supervising teacher, follow the existing methods, protocols, presentations, this is how we do things, follow that with a given class. It might vary but often a teacher will be doing the same. They have gotten the students used to their methods but hey are also using their methods because they know what words for those students, so I would say follow that and once things are flowing add on your little ideas don't just be like me and jump in with ideas that are incoherent. There was one more really really important thing; classroom management. Don't even get started without classroom management because you can have really fantastic lessons sitting there and everything but if their volume is too loud and its completely off topic and everything like that they don't even wana hear you, they are not even going to learn how to do an activity =, they're not even going to hear your instructions, I am a pretty chilled person and in a classroom situation I am not an angry person, I don't really see myself losing it, it's just not my style, I am quite chilled and quite respectful with the kids, and I like the kids essentially. But having said that you have got to be firm, you have really got to be firm. So I had a lesson where my teacher said, she was down in admin and she could hear my class, because they were so out of control, but then when she walked up push came to shove, I had to do classroom management, these are good kids, they came on board. Yea I might have sounded a little bit desperate, but I got that class to bring it right down. I could have run away crying and screaming but I'm like no, it might me miss's responsibility it might be your responsibility, but you guys have got to calm down…. this is what I want you to do, this is what's going to happen. I managed to bring that volume down and then similarly in one of the later lessons with the same class, there was no teacher there, there was a teacher's aide, she did stand outside the classroom deliberately for a short while and then they were quiet.*
*It's just setting those guidelines for behavior just like how you would set guidelines on actual content. That's what I would tell them*

***We have come to the end of this interview***

**Semi-structured interview of the supervising teachers? (RQ 1, RQ2)**

**Aim: Strategies that the PSTs used to motivate science students during their professional experience placement**

**Name: Cassandra**

**Time: 9 am**

**November 2019**

1. **What strategies did you notice Paula use to motivate science students during her professional Ex placement?**

*She informed them. She was good at information giving, questioning. Questioning, I got her to eventually question so it was relevant to the students and where the students are at, what was happening around with them.*

*To motivate the students, she gave some of her own personal experiences and made it more applicable to them.*

*She eventually used a lot of visuals on her One note. I am thinking mainly for the bottom year 8s so that they could look at the diagrams and the colors and everything else that actually engaged them as such. There were some other things, but I can't think of them right now.*

**Can you give me an example of a time when any of those strategies worked?**

*They were doing ecology and I remember one lesson where she again making it applicable to the current time, she talked about the Greta Thronberg talk. She played a snippet of the Greta*

*Thornberg speech that was recently given and interestingly enough and soon as it was turned off, one of the y8s said "what a hypocrite!!" and to her credit she handled that well in that it wasn't about putting the kid down or anything, it was about exploring why he thought that her points were about. She encouraged him, no just him but others to give their points of view and she invited other feedback from other kids from the room who weren't actually participating so that's good.*

**<u>Can you give me an example of a time when any of those strategies did not work?</u>**

*I think a y9 group, they were also doing ecology. She wanted to take them outside to have a look at abiotic features outside and she took them up to a garden area behind the school and said to them list the biotic and a biotic around here. She didn't really explain it. And then there was a-- for about 5 minutes and then the bell went and then when she left I said *look around you, you have a dead tree maybe you could have talked about what biotic and abiotic factors that could have influenced the dead tree and have a look in the garden, you had some plants there that were diseased which are biotic factors. There were some areas where they could have been used to motivate a lot of discussion with the things that were applicable at the time, but it wasn't used that time. Mind you it was still early in her placement and she learnt as she went along.*

**<u>Were there any factors that influenced the strategies she used to motivate students?</u>**

*Me, I was the factor.*

*Because she was in her first year and her very first prac. She off course like all first year pracers are out to teach, and I was trying to get her to realize that her job isn't to teach, her job is to get students to learn. Because when you teach all you do is just impart information and it was all about how to do that but get them to learn such. SO I supposed I was the factor that kept pushing* *her in the direction and therefore to look at ways, how they are going to learn through, as I said before, using the local environment or something that's current or applicable to them. (6m 14 s)*

**<u>Can you give me an example of how you as a factor influenced the strategies, she used to motivate science students?</u>**

*I suppose because I have got more experience than her, I was able to just think at their level and think and know what they are capable of and what interests them and what language to use and therefore I was able to direct and guide her lesson planning before she got there on how to use those things so that the kids were engaged and motivated along the way.*

***Were there any other factors that influenced the strategies Paula used to motivate science students?***

*She was a member of Land Care which is, as I said both classes were doing ecology so she was able to draw on her own practice of that and apply that to her classroom experiences and examples. She demonstrated and did a lot of practical and experiments to try and introduce different variables.*

**<u>How have Paula's strategies for motivating science students changed during here professional experience placement?</u>**

*She got more confident, and more knowledgeable of the students. The syllabus says know students and how they learn so she by the end of it was able to do that a lot better than what she* *did at the beginning of it. She was able to be more comfortable in the classroom, be more confident and that comfort and confidence allowed her to know her students better so that she knew where to pitch things and what they might enjoy, what angle to go for things and things like that. So, time, comfort confidence and comfortability.*

**What are the types of experiences and guidance have you provided the pre-service teacher on how to motivate science students?**

*Do you mean other than talking to her? I suggested that I teach again and then she observes my lessons. She observed all my first week lessons. We got to the end of the second week that she was teaching, and I suggested that I take a lesson for each of the years just to show her what I've been talking to her about so that I could I could put it into practice and she can actually see it unfold and how it worked.*

*She seemed to get a lot out of that. I asked her to around different teachers in different subjects, so they were able to show her their teaching styles.*

*She spent a lot of time speaking to people at sport and staffroom, so she was forever gathering information about strategies which was very very good.*

*She always sent me her lesson plans, so I looked over those and offer feedback.*

*I've shared resources.*

**Which was the most successful strategy you think she used?**

*The best lesson I suppose was one of her very last ones where she felt really happy because, and you can see it in her teaching, she was comfortable she was confident, and she owned the* *classroom. She owned the classroom because she was projecting her voice, she was standing to the front of the room or to the side of the room and asking them to project their voice. There was conversation between the kids and the teacher but it was all done in a very relaxed but controlled way, that a lot of energy was in the room and it was quite successful.*

**<u>Which strategy was the least successful one?</u>**

*The least was that she didn't listen to me. Again, right at the beginning all see and other first year pre-service teachers are interested in is getting the content out and that's never ever going to work.*

*It didn't matter how many times I talked to her, I had to let her fall on her face and then she was able to get it. It made sense to her.*

**<u>Was there any other guidance that you provided Paula?</u>**

*My unconditional time, it was hours spent with her everyday. And as I said she was able to utilize other people's resources and time and knowledge and wisdom which I thought was very very good.*

**<u>Is there any advice about how to motivate scence students you would give to PSTs preparing to teacher science</u>**

I suppose what I have been harping on about that it's not about teaching, its's about getting them to learn. They are not going to know that, doesn't matter how many times you tell them it's not about, there's the syllabus , not going to impart the syllabus , It's not about that , it's about how are you going to get them to learn those particular things . You have to think from their point of view not from the teacher point of view. So know your students and how they learn, know what their language is, know what interests them , know their names , she was very good at knowing their names . that was a big motivator for her and for them that she knew their names. I think that’s the main one

**Elsa and Lorna Collated interviews**

**Semi-Structured Interviews**

**Duration: 45 minutes -1hr**

**Interview One of PSTs before their professional experience placements.**

**Goal: To find out about the pre-service teacher espouse theories about student motivation.**

**Participant #2:**

**Program: Master of Teaching Secondary**

**Year: 1st year**

*Theme One: How are espoused theories and theories -in-use of motivation are developing during their professional experience placements? (Main Research Question, RQ1, RQ4)*

1. Can you tell me about your experiences that led you to develop your own ideas about motivating your science students?

**I think part of it comes from when I was at school and probably not having a lot of realworld connections or understanding why we are learning specific things. So, I think one way to motivate students that I'll try to use is bringing in real world: Why it's important, why would it be important to them and how it relates to their life outside of school.**

2. *Are there any other experiences that helped you develop your ideas for motivating science students? Can you explain that?*

**I suppose relating to that, from observation days, I saw teachers relating it to real world experiences. I think another strategy would be doing practical investigations, more hands on because certain students, that's more up their alley than just sitting down and writing notes. That sort of gets them to take that step further.**

*Are there any other experiences that led you to developing your ideas fair how to motivate students during your professional exp. Placement?*

**I suppose, teaching at the uni. It's sort of a bit different. I have worked as a demonstrator in a laboratory so I've seen how different courses are run. One of the courses I first saw was a first year Biology course and that was really motivating for the students because its more investigative and really built on teamwork. I thought that was beneficial and it related really closely to what they were learning**

3. Have you experienced anything during your studies that has led you to understanding how to motivate science students? Can you explain that?

**One of my science courses, we had to make a WebQuest so I thought that was quite a motivating. A WebQuest is like a research project but you have to direct them to the websites and different places to look. So, I think that was motivating. Also, during my education psychology class, my tutor used cahoots and we all found them as uni students quite motivating and realizing what we didn't learn at the lecture or things like that. I think that was quite motivating and it was fun and made us revise the content, so I suppose that can could be taken into for science students.**

**I don't feel as if we have done a lot of "this is how you motivate the students" and I think I'll probably get more of that at the school on placement.**

*Why Do you say you think you will get to know more when you are out on placement?*

**I think because the teachers know the students, they'll know what motivates their students.**

*Theme Two: Factors influencing how espoused theories are enacted during the professional experience placements (RQ1, RQ2, RQ3, RQ4)*

1. What strategies do you think you will use to motivate science students when you go out on your professional experience placement?

**At the moment I don't feel as if I have a real set idea because I know when I go to placement we are gona have, our supervising teachers will want us to have at least a week, if not a bit longer observing and I think that might be due to the behavior issues they might have at that school. They just want us to observe and see how teachers teach and observe a few different teachers and look at how they manage the students and I suppose motivate them as well. So at the moment going in not having known what school I was going to I probably would use a lot of hands on investigations, practical work cause I know students are motivated to do them. The don't like writing notes so that would be one way to motivate them. I think even games to revise, its like Kahoots. Giving them a bit of choice in what they look at rather than just this is what you've got to study. Allowing them to have a bit more choice as well. (Choice in ) How they conduct the investigations, how they, what tests they do so that they're planning the investigations partly themselves even if its just as a class and you're directing them but they feel like they have designed it themselves.**

2. How effective do you think those strategies will be? Why do you say that?

**Depends on the student 'cause I suppose some students might tick over will be really involved whereas some other may stand back. So I suppose it will be the working, trying to manage group work encouraging students if they are a bit more hesitant that they can have**

**a go.**

**That's what they're signing up for learning environments so they feel comfortable giving answers and not feel worried if they are getting it wrong, that it's a learning process. Depends on the school and what they allow, but even mixing up maybe going outside to do activities because some students will learn better in more outdoor areas. One way to motivate is to mix up the activities. In June when I went into the schools, they said they try and break up the classes into three activities at least because the students don't concentrate for a whole period on the same activity. So breaking it up using different activities to make the lesson interesting so they don't get bored.**

3. Is there anything that influenced why you will choose those particular strategies to motivate science students during your professional experience placement? Can you explain that?

**So part of it is from when I was at school, when I taught at uni and also going through the master learning about the quality teaching model and also the 8 ways pedagogy for aboriginal students as well.**

**So I think from school, the lessons I remembered the most were when I am doing activities. I don't really remember the ones That I've written down notes for the whole class. I particularly remember going out in agriculture and looking at the plants, pulling out the legume, looking t nodules and that's what I ended up studying later on. So that sort of stays with students more if they are actively doing something that means more to them.**

**Other than that it relates back to the quality teaching model by linking back to the students' life, making it significant to them.**

Is there any other thing that influenced why you will choose those particular strategies to motivate science students during your professional experience placement? Can you explain that?

**I suppose cause I have done a lot of research work, having worked in the lab to me science is a lot of hands on activities, learning skills and designing experiments. So, I think that's probably why I think more hands-on investigations and I know that school students want to do more practical investigations.**

You also said Games as a strategy, what influenced you to choose this strategy:

**I think games for revision, I think they are quite good. When I have lectured I've used cahoots for revision; Its like. Quiz online so I can see where the students are having trouble**

**and they can see instantly whether they got it right or wrong and how they compare to the rest of the cohort. So I think they enjoiy it, its hard to tell in a lecture environment as much as I try and get feedback, its just how much they respond.**

**It depends on the schools policy on phones and whether they can have them out. So another option I have seen in a physics lecture is using just colored ABCD, colored bits of paper that they can flip to show their answer. That would be an alternative if they can't use a phone in class.**

How do you think being on your professional experience placement will help you develop your ideas for how to motivate science students?

**I think it will help a lot. I suppose because my experience is more in uni or having students being selected to come to the uni from high school. They're probably more top, more motivated students so they just get on and are intrinsically motivated to study. But I think during the placement I'll have students that need a bit more of external help in motivating themselves so I have not really have experience in really motivating students from not**

**being motivated to really involved. I think it'll really help. I think having the teacher present (supervising teacher) will provide ideas and strategies for motivating and then also observing that teacher and also the other teachers that I hopefully will observe. That might assist in determining how to motivate students And I think each student will be different so they might need different tactics to get them involved. I think mixing up the lesson making sure there a few different activities so that even if they are not motivated in one activity maybe they'll come back into the lesson and continue in another activity.**

Thank you very much. We have come to the end of the first interview

**<u>Participant 2A</u>**

**Duration: 25 Minutes 29 seconds**

**Interview Two of PST during their professional experience placements**

**Goal: To find out how PSTs are using their strategies to motivate science students (RQ1, RQ2. RQ3, RQ4)**

1. **First of all, how's it going?**

*Yea, it's going good. I am enjoying it.*

2. **Can you tell me about a science lesson when you felt that you really motivated the students?**

*I think there's been a few and them mostly when they are doing prac or hands on activities and also some videos. The pracs when the year 8 made a catapult during their energy unit. Year 7s they seem to be quite motivated making the slides. Yesterday, in the bouncing ball experiment for year 8.*

***How did you know they were motivated?***

*They were engaged, With the catapult I had like chocolate rewards for the best teams so that grabbed some of them. Most were engaged and busy working. Some of the students I found do more written work, they actually got involved in the making of it, so I can see that that it was a way that those students learned.*

*Other times year 10, I did a web quest with them and they seemed to enjoy that, they were working at their own pace, because they can work at their own pace. But they were all on task, I didn't see anyone on the wrong website. So that was really good.*

***So for the classes when you motivated the students can you tell me what time of day it was, or day of the week?***

*Morning. Fifth period I've been really surprised. My supervising teacher thought it might go pear shaped. In year 7 we made a model cell out of plasticine and it was a fifth period class, the last period and they all did beautiful work, got into it. We did have a lot of students always, so it depends on what students are here. The ones that are a bit more troublesome, if they are not around, they don't pull others in and they stay motivated.*

*Another example of motivation year 7 was they really liked Bill Nye, the science guy video; *He does videos on science* and they were engaged in that singing the theme song as it started up. They really enjoyed those videos. I personally probably wouldn't have picked it but my supervising teacher suggested it and they were all excited to have a Bill Nye video.*

3. What main strategies have you been using to motivate science students?

*The main strategies are, I suppose written work and I have been giving like time, some of them don't like writing too much so I would put a small amount of writing up, I don't put too much.*

*Using videos, Youtube videos*

*And practical lessons or drawing diagrams*

*So my students might get in and do their work but for the students that aren't working I'll go up to them and ask them why aren't they working and maybe give them an alternative if they're not going to do the main, say if they are not going to write down all the work, I'll say ok if you're not going to write down the whole vocabulary definition how about you just write down the vocabulary words or.. So they are doing some engaging in it.*

***What does the names do? How would knowing their names motivate students?***

4. **On a scale of 1-10 with 10 being the highest rating, how would you rate the effectiveness of strategies you have mentioned? Why would you give that score?**

***Written work:*** *For some of the lesson I've been doing vocabulary definitions; here's like 3 vocabulary words, here are the definitions. I think it's good to give a structure to the lesson so they come in and they can just start writing down notes, so it calms, sort of like a technique to calm them down and get focused. If there's a lot of writing it's not motivating, they'll just look at it. I think if I have it on the screen projected, they are less likely to write it down. What I've noticed is if I've written it up on the board, they be like ok, we'll write it up. And it depends on the class, some like writing notes and it just depends on how they're feeling really, I think. I think in general motivation wise I think it's like not very high, so like 1/2. But I think sometimes they like that they don't have to think, they just write it down.*

***Videos:*** *It depends on the video. I think sometimes it can be like with the year 7 with the Bill Nye, I think that was a 10 for a lot of the students. Some of the students still wanted to look on their phones so it really depends on the motivation of the students and were they distracted by something else. So sometimes you have to wonder around and be like we're watching the video.*

*Year 10 with the universe they were, I don't know, some were motivated to watch, others fell like a bit testing and just wana see how much they can get away with so they don't pay attention. So it just varies for the video, the interest the students have in that video. Year 7, they seem to like videos. Year 10 it's a bit mixed, I am still working out what year 10 really likes.*

***Practical activity****: I think it is probably about 8. It varies, some students I don't think like practical work, like --- One of the students said he obviously wasn't participating that much, he was just busy colouring in. Some students clearly don't like prac work whereas others really engage in it and prefer it over more written work.*

***So, if they don't like prac work what would you do?***

*Sometimes I would find out if the student or why the student is not engaging. I n some cases there's like social issues. So maybe if it's group work they might not want to work with certain people so like yesterday I talked to one of the students and found out that she didn't want to work with a lot of people but she wanted to work with only one group so organized for her to jump into that group. I just try and get them to participate or maybe* *say *I'll help you* I think if I help them, cause sometimes it might be that they're not sure what to do, so maybe I'll make suggestions of what they can do or demonstrate more to them.*

***Drawing**: It's about 5 or a 6 but it really depends on the class, how they're feeling. Some of them really engage in it and do beautiful work and then others blatantly refuse to do work. I had a year 10 class that was like *miss is this your idea of fun? * I am like, well I am just trying to make it work, I am giving it, you don't have to write it down.*

*I think Modelling, so the year 7 class that modelled the plant cell while working with plasticine. That was something different, so that was motivating, and it was more kinaesthetic so that might have motivated students that liked to be hands on.*

**When you give the students alternatives/choice, on a scale of one to ten how would you rate that as a strategy to motivate them?**

*I think it can motivate them. I think for the students who are struggling academically, giving them choice is a good way just to bring them in and get them to start doing some work. I haven't been giving them too much choice, like you've got to do this or this. So with the plant cell modelling they got to choose if they wanted to do animal or plant cell but I haven't really given them an open ended...I suppose with the catapult, it was up to them to design, so they had choice in that , but really the main choice I've been giving is like how much they do or ok if you don't want to make a slide maybe you use the one I prepared earlier and have a look at it under the microscope or just slight modifications. I'd like to do more choice but I think it's a but hard, sometimes when it's really open it might be hard for them to engage, or I just don't have enough time to prepare a lesson that has a lot of choice, it's easy just to go this is…. I've given extension work, like if you have finished you can go on to this, do extra work not from the get-go or you have two options.*

5. **Are the motivation strategies you are using now different from the ideas you perceived before our professional experience placement? Can you explain that?**

*I think I originally said practical work, videos, hands on activities, so I think they are motivating but I am noticing that they are motivating for the majority of the students but not everyone.*

*Yea the practical work and the hands-on activities. I probably rated writing down low to engagement but I feel like you can't…. You still have to get them to write notes. You want them to have notes in their book. I think writing notes has a place, but it's just working out what the class, what level and how much writing that class can do.*

***You said writing down notes has its place? Can you explain that?***

*Those students that want to study might not be many, but if they want to study it's good for them to have notes that they can revise. So if we just talked about things that are happening or they are learning about they would have something to go back to. I think you can't always be printing out worksheets, it just ends up being too expensive. In some cases like year 7 I was doing a lot of work sheets because they can't write many notes so it was more like closed passages or questions.*

*I think questions are good. I think also giving them activities like worksheets that have activities that are clearly laid out, that seem to be, motivating to the students too. They liked having, this is what I'm doing.*

*And going outside and doing pracs outside it's engaging for students as well.  So doing like bouncing ball, energy efficiency, catapults. We looked at, year 10 we went out with a telescope and we were looking, not looking at the sun but shining light into a piece of paper. We were going to try and burn the piece of paper but it was not that was really Smokey so I don't think it was good. Some [students] were engaged, some were busy. Prior to doing that we did expanding the universe with the balloons, so some were distracted by the balloons. I feel like the balloons were engaging but were also distracting at the same time while doing the practical work, but I'd run it differently next time.*

***Which strategy would you say is the most effective for motivating students for learning sci ence?***

*I think the hands on practical, whether it's modelling, even drawing, but I think hands on practical. But I don't know whether that's because I enjoy those lessons. Because I can walk around and interact with each student more on an individual level. So I think that's one of the reasons why they are good because it allows me to walk around individually work with groups and asked them questions rather than being me asking the whole class and they might not answer questions.*

***Which strategy would you say is the least effective for motivating students for learning sci ence?***

*Probably writing notes down.  I haven't pulled out a textbook yet. I haven't got them to do textbook work but writing notes.*

6. **Can you describe a lesson where you successfully used a strategy/strategy to motivate science students?
What year level was the lesson taught at? What topic was being taught?
What time of day was it?**

**What strategy/strategies were they and how did you use those?**
**Why do you think using that strategy/those strategies were successful? **

*I'd say year 7, Modelling a plant cell with plasticine and one of the engagements was I either gave them B-Bucks or chocolates. B-Bucks are like the behaviour bucks, so they get these for good behaviour. They are like PBL bucks/ dollars that kind of thing and they get them for good behaviour, and I think they collect them all they can get a reward at the end of the term.*

*For some that motivates students. For Year 7 it works quite well but year 10 not as interested. For Y8 chocolates worked quite well.*

**What time of day was that lesson?**

That was period 5 on a Friday afternoon and they worked really well. I think I got them to draw out cells; drawing and labelling of cells and I think I had two images of the plant and animal cell. They got to choose, which cell they wanted to make, the different colours that they produce. They prepared a cell using plasticine, so it was 3D rather than 2Dso they had awards and we made it a competition and they all came around and showed each other the cells and then awarded a winner. They were all pretty good, so we just gave it to everyone.

**Why do you think those strategies were successful at the time?**

I think it was fun, hands on.  And I think they like the slightly competitive in a way. I think just showing everyone what they've done. I think that's a nice way of saying this is what I 've done rather than ending the lesson and you just do your own work.

7. **Can you describe a lesson when you used a strategy or some strategies to motivate science students unsuccessfully?**
   **Can you explain why you thought using this strategy or those strategies did not work at the time?**

*There's one I can think of year 8, it would have been Thursday period three after sport probably, because they do sport in the morning. So I was wanting them to do, I gave them a table, in the table there were different types of light bulbs so I know, halogen, LED, lightbulbs and there was information. What I wanted them to do was complete a table about the pros and cons of each light bulb, like environmental issues, legislative issues, things like that. So I had the worksheet and I had to write it up in a table and they just did not engage in it. I think it might have been if I did that lesson again, I wouldn't give blocks of writing, I would break up the writing, just, make it more accessible and easier for them to find information. I think a lot of them just a=saw all the texts, it wasn't heaps of text but they looked at it and they just scoffed at it, they didn't engage* *with it but then the next lesson, I left it for homework and a lot of them did it for homework so I don't know whether it was just -they needed time to read. I think I gave an example later in the lesson so that might have helped them know what to do. I think I needed to sort of scaffold a bit more at the start of the lesson and that might have helped engagement. I find that if I don't explicitly say what to do, and it's probably being a new teacher, I just assumed they know what they are doing, but they don't. I need to specifically tell them what to do and t=I think that helps in engagement cause they're not. if they don't know what they're doing and then obviously they might just not engage cause they don't understand.*

***What do you think this strategy did not work?***

*It might have been pitched at a higher level. I might have had to bring the literacy level down a bit to make it a bit easier.*

8. **How has the guidance from you cooperating teacher and science education subject educators helped you in motivating science students?**

My supervising teacher had a big influence I suppose because they know the students, so they know what they can do and what level they are at. That has been really helpful.

**When you say what level they are at? Can you explain that**

Like what amount of writing they would do, level of literacy, whether to give a worksheet or have them write it out or those sorts of things. Just suggestions of pracs to do and I suppose after the lesson talking about what went wrong, more reflecting.

My tertiary advisor mainly talked about behaviour management more so than engagement. The main thing I got back from afterwards was how to bring the class back if they are starting to get rowdy So I have been doing 3 2 1, but over a time if you keep using that in a lesson they don't pay any attention. So just talking about different strategies I can use to bring all the students back. So more hand gestures and things like that. I suppose it's harder when the tertiary supervisor is not a science teacher, they might not…It's different they might not suggest –I guess there are similarities and differences as well.
That lesson my tertiary supervisor observed was, they were drawing a diagram of mitosis in year 7. And they were pretty all switched on so they were all engaged in it so maybe that's y he didn't talk bout engagement as much.

**Participant: Elsa**

**Duration: 45 mins 12 seconds**

**Programme: Master of Teaching Secondary science.**

**Interview Three of PSTs after their professional experience placements**

**Goal: To find out whether the pre-service teachers' perceptions about student motivation before their professional experience placements changed during their professional experience placements (RQ1, RQ2, Main research question)**

**How are you going?**

*Yea good.*

1. **Is it possible to remind me of some of the strategies you used to motivate science students during your prac?**

*I can remember what I said last time, but one of the main motivation strategies I was told when I got to the school was that the students can't concentrate on doing one thing for the whole lesson, so at least break up the lesson into 3 different activities so they can maintain engagement in the lesson and if they don't enjoy one part they can enjoy the later parts hopefully. So I use a lot of practicals, going outside and maybe doing the practical outside or doing the testing of whatever outside, collecting plant material outside, more hands on, kinaesthetic activities. My secondary* *supervisor suggested for year 7, that I was doing a lot of reading and writing, watching a lot of videos but I wasn't using a lot of kinaesthetic if that's how some students learn that's a good thing to include. I made models, did more drawings and hands on type activities and then watched videos related to the science. So the amoeba sisters videos and the year 7s really liked Bill Nye videos, so I used them.*

2. **Can you describe a lesson where you successfully used a strategy or some strategies to motivate science students?**

   *With Year 7 I did a Bill Nye video with a comprehension sheet. While they were watching the video, they had to fill out the comprehension sheet. I think both worked together, I did it twice with year 7, they sort of liked filling it out and getting the answers to everything. That was sort of like an engagement, like can I get the answers but then they were also watching a video so that was engaging too.*

   *Year 10 I used videos for the universe, I think cool videos but the level of engagement was mixed. I felt that the level of engagement was mixed. I felt it harder to engage because they are coming to the end of year 10, they had their exams on and they had a prac student. I knew they were sorta testing so I felt the engagement was different with year 10 and year 7.*

   *Year 8, I didn't really use any videos that much with year 8, but I think that has much to do with the topic. The topic was on energy transformations*

   ***How did you use kinaesthetic?***

   *I suppose I used that when they modelled the plant cell. So with plasticine, that's a very kinaesthetic thing to do.*

   *Year 10 we did a model of the universe. They had to blow up a balloon, put dots on the balloon and then measure the distances between the earth and the different galaxies that were the dots on the balloon.*

   *I suppose other practical work was kinaesthetic as well. When the year 8s made a model kettle, measuring the temperature of water all the time.*

   *With the year 10s that was second period and they had a yearly exam 3rd period, so it was more like just a fun lesson. But didn't want to pull them back. They like going crazy with balloons, but I couldn't really do anything like keep them back at recess because they had their exams straight after. And then we looked at a telescope*

   *Year 7. , that was a morning… My supervising teacher thought they wouldn't go very well cause its fifth period on a Friday when they did the plant cell, nut they all got in an did a really good job.*

***Why do you think that using the aforementioned strategies were successful?***

*I think they were successful most of the time because they didn't take up the whole lesson and I was taught before to break it up in at least 3 sections. With the plant modelling I think I might have had a video before it and some note taking, so a sort of a break. In some of the practical things I brought a competition, prizes for the best so that they also engage. I gave chocolate or B-Bucks.*

*Year 7 with the cells I did b bucks and that really worked. Another engaging thing I did when my tertiary supervisor came in, I saw my teaching supervisor do it , was she gave all the students a b buck, PBL thing as they walked in the door and I had a question up on the board that they had to answer. They answered it on the back and they put it in like a lucky dip so that at the end of the class I pulled it out and saw who got the right answer and an got a chocolate reward at the end of the class. That motivated them in finding out the answer cause the class was on cell division and mitosis so the answer was mitosis and they were like---- and I was like – Whispers***its up on the board***and they were engaged in that part. I Don't know how well it engaged in their learning but it got them I supposed a bit hooked into the lesson. (8:15)*

**So you said you went outside to collect samples as well, how do you think that strategy successful/ worked?**

*I think it was good. I think there was a bit of mixed engagement but having observed that class before there is a lot of mixed engagement. Normally each week mostly they go down to the farm during that lesson so they're used to doing that and some of them will just mock around but I think overall they are all engaged when we came back to do the microscope, they were all working and mostly looking at things. I think it was good to have that break, they got out of the classroom for a bit and then came back. I think it might work better for a class that does not normally go outside. It would be good to see how they would react to that, I think they might react better and be more engaged because it's a new thing whereas with that back yard blitz class they do that every lesson, they go down to the farm every lesson. If they didn't go to the farm every lesson they might go –ok this is cool I am going down on the farm so that might be different.*

3. **Was there anything that influenced why you chose those particular strategies to motivate science students? Can you explain that?**

**Practical hands-on, videos,**

*I think, those things are mixed with doing a bit more written work, videos, worksheets activity sheets. I think year 7 worksheets and activity sheets worked well and year 8.*

*Worksheets were chosen because my y7s were low literacy and they couldn't write a lot, maybe 3 dot points and they are like that's it I 'm done. So I think worksheets were good cause they still* *had to work. They had to actually think as well rather than just writing down notes. They had to think to answer questions and then we could come back as a group and go over the answers. I suppose it something they know they have to do, they can see it in front of them and they know I've got to answer these questions. I think they need a little structure I suppose, one of the things I realize when I went in was that I wasn't giving them enough structure, like I wouldn't specifically tell them ok , go and work out the work sheets on the side bench and a lot of them wouldn't engage in that and that was because I didn't actually specifically go this is what we're doing, now the sheets are around the room, you've got to go and answer them.. Like really outline what they have to do.*

*Another thing for engagement was just scaffolding what they should be doing. And the reasons why I chose the different activities practical just because science I think should have a practical element to it and you find students asking you 'miss when are we going to do a prac lesson?"*

***Why do you think that?***

*I think as having been a scientist science is hands on and trying to problem solve and skills based and using your hands. I think it just accompanies the theory side; goes hand in hand with the theory, so if you can do it there then you can visualize it.*

*When you say theory can you explain that?*

*The theory that the students will learn, so the notes that they take or the worksheets that they fill out. For example they were doing energy transformations the other day, they had electricity; what's the energy transfer in a light globe? So it's like electrical energy into light energy. They could do that really easily but having them make a kettle that made them go aww. So there is all this stuff where I have set up circuits in the past using the powerpack, that is putting electricity in, that is heating up the water, that's the energy transfer and then how can me make it more efficient.*

*Going outside, I know some students in some cases they were bouncing balls, so it was safer, more manageable if they had basketballs outside, there is more space. It's mainly safety really but I know they enjoy going outside. It gives them a bit of a break from the classroom and some students prefer that more so.*

**You also mentioned catapults as well.**

*Yes catapults, we went outside, they made it all inside, but they did all the test outside cause for some students it went 10 meters or more, so it needed to be outside.*

**You said some students were engaged, what about those who weren't engaged, how did you motivate them?**

*Mainly just going around and checking and saying, do you know what we are doing? What group are you working with? Some students it was because of social interactions, they didn't want to work with a group so one lesson *catapult lesson* one of the students just sat there, I offered here that she could make it herself. I'd help her, we can work together to make it, she could work with a group of her choosing but she just wasn't engaged. Then when we made the kettle, she was sitting there not joining any group and I went up and was like what aren't you doing it? do you want to make it yourself? Do you want me to help you, because I knew she didn't like people in her class, is there any group you would work with? And she is like I'll work with those boys but they've already got four people. So I am like that's totally fine we can make it bigger to five, that's ok. In the last lesson I had year 8, they were using physics classroom simulation of a roller coaster, looking at energy transformation, and she was like into it, because it was just her doing it. She was like aww come over and I'll show you. She came over to show me what she was doing. That was the first time I'd seen her really engaged in an activity.*

*I think mostly doing solo work on the computer can engage a lot of students. That one was an activity where they could've moved these little grey dots and it changed the tracks of the roller coaster. So I suppose she didn't have that social issue, she could have done her own work and be proud of what she'd done and I could ask her questions about, do you notice the kinetic energy, the potential energy. Also when y10 did a webquest, I just gave them the websites to go to and they had to answer questions and they were all were doing the work, some might be slower than others but they weren't looking at other websites, so that was good engagement. So I think they enjoyed working at their own pace.*

**4. Can you describe a lesson when you used a strategy or some strategies to motivate science students that did not work?**

*I had one lesson that didn't work. I gave them a worksheet, so they had to do comprehension, it was a lot of writing. They had to read and then summarize that writing into a table and they just weren't engaged in that. But it was after sport so like 3$^{rd}$ period around 11. They just weren't really engaged, they were struggling, so I think I aimed the written work at a higher level than they could work even though I took it off the internet that was aimed at a year 8 class, but they struggled with it. It was a Thursday. So I don't know. But when they had to do it for homework, they went home and a lot of them had answered the questions, so I don't know whether it was just… some of the students weren't engaged and they were quite characters and then that spread through the class. I just don't think they were engaged. I suppose I had to do work that didn't seem easy, it wasn't, they thought it was a gap they had to fill out and put the word, they actually had to read it and comprehend it.*

*But then that could be on my part too. It could be that I didn't engage them. I suppose one of the main ways of engaging is in your introduction to hook them in. I think being on my first placement, maybe I am not as confident as someone who has done it for years so I think that will come with time, that I'll get to engage the students more with stories. I think I was, in some cases quick to say 'the kidies know what they're doing' and then move on so think over time I probably engage them more at the start. I tried but it just gives us lots of things to think about.*

***When you say characters what do you mean?***

*Like asking questions, being the centre of attention, I suppose.*

***What do you mean by a hook?***

*Just to get them aww this is what we're learning about. To get them a bit excited about If they are not super excited I don't think they will go about Oh Wow!! But get them a little bit interested in what they're going to be learning about.*

**How has being on your professional experience placement helped you understand how to motivate science students?**

*I supposed it really showed that each student will be motivated in different ways and that you've got to do different activities throughout the lesson.Where as I have heard that at other schools they can do the one thing for like the whole period. But it just depends on the student and the cohort.*

**When you say depends on the student can you explain that**

*Well one of the other interns on placement, he was at a selective girls high school and he said they had 80 min lessons and they just did their work for that period of time. Whereas at the school I was at they needed more scaffolding and more segmented lessons to maintain engagement, so it didn't seem as though there was too much to do. I think that was obvious, like that was a thing I learnt more, so that depending…. It was really variable so sometimes I saw y7, they were really good last period on a Friday but a second period earlier in the week they just were crazy and it was all due to the lesson prior so that can change. Engagement can change*

*based on what you're doing and teaching them, but it also depends on what they've come from and how they're feeling.*

*When you say how they are feeling can you explain that?*

*That lesson I didn't really break up into 3s but they were all pretty engaged in writing the questions. I think it's because they did have their exam, and I said *I just looked at your exam and I came up with these questions to help you study* So I think that was engaging, they were like *aww we can get something out of this* so they were quite engaged because they had an exam the next day.*

*Whereas y7 they came from English, they had a casual teacher and they didn't like English or something happened, and they were just all hyped. You could just tell when they walked in they were like *what is happened here they're all hyped up**

*I think Monday morning takes them a while to get back into school routines as well so that can change engagement. I think on the Monday I was in the staffroom and you could just hear. There's a lot of noise.*

*I think practical.. a lot of the boys that didn't engage in writing, trying to avoid writing as much as possible, they were really engaged in the practical that were making things or going outside. That was good to see.*

**4. How did your initial beliefs about motivating science students compare with your motivational beliefs during and after your professional experience placements?**

**During prac beliefs comparison to prior beliefs**

*I suppose we had to do an assignment before going on prac about what lessons we were engaged in in science and what lessons we weren't engaged in. One of the ones I said I wasn't engaged in was just how to write down notes and a lot of notes. So I knew that wasn't engaging but there is a place for it. I am a student that will study my notes, so it was good to have written down notes because you don't always have a textbook so it was good to have my written down notes. I could go through and study for the test whereas at placement I knew they wouldn't like writing but they really didn't like writing. I swear I wrote a lot more down at school that they. If they had to write a lot they just switched off. When I was at school we didn't have computers that connected up. We would just have texts so it was either an overhead or the teacher had to write it up on the board and I found that if you put the writing up as a PPT slide and it was all up there, they were like ahhh I don't want to write that* but if you wrote it on the board they were more engaged in writing it down. I don't know whether it was because the words came up gradually, it wasn't just a massive text, it was gradual put up. They were like miss is writing it so we can write it too. It's jut something about it that made them more likely to do it. They didn't complain as much. I was surprised at how much they complained about writing not a lot down, that was a big thing. I suppose it would vary at different schools and how much exposure to writing they had.*

*Another engagement was like videos. I thought videos would help. I didnt know how much they would take in off a video and how long the video could be to hold their engagement. I was thinking more short, max 10 mins videos so they would stay engaged in it, because I have seen when I did observations, some of the videos I think they were pitched a bit higher, like I could watch them at university. I thought they were pitched a bit to high and then the engagement was lost a bit and they were a bit long. But then I would show the y7 a Bill Nye video on recommendation from my supervisor and that* *would be a 20-30 minute video and they were engaged for a fair amount of time but you could see how he designed the video, It was sectioned and had interactions and was interactive. It was on cells so there were questions like; is it alive or dead? And one of the boys who has a number of different learning difficulties wouldn't write anything down, gave hm a worksheet and did one thing on it, he wasn't engaged but in that video he was calling out *it's alive, its dead* you could see that he was engaged in the video, so that was really interesting to see. So the videos will help in the future in planning.*

*Practical side:*
*I don't know if they were engaged but it was interesting to see students that weren't engaged in the practical work. One y7 student really didn't do any work, he was there drawing, and I suppose I still need to learn how to get them to do work. You have to be *you have to do it * or I try to offer alternatives but that sometimes didn't work with some students*

**Why do you think giving alternatives worked with some students and not others?**

*I think it depended on the alternative, whether it was easy for them. I think it worked well with a student I had in y7 because he wouldn't do work, when he was watfching the video, he got engaged in the video he had oppositional defiance disorder* so I think it worked giving him alternatives rather than being *do your work!!* because of his learning difficulty that would have flared the problem more whereas if you went *aww heres an activity sheet would you like to have a go at?* and then I walked away, he is not being pushed to do it, so that helped him.*

*Whereas with the other student, I don't think he had that learning difficulty problem, it think its more he wasn't properly engaged or he was just not having a good day potentially not interested. Then some of my y10s, trying to get tthem to do work, I think the motivation behind them not doing work is just lets test miss and see*** I really think. Because you are like *write it down* so I think to get them motivated I probably needed to just be that's it *you're coming in at recess* Making it like there is a consequence to not doing the work because I don't think giving them alternatives would work. So a student instead of doing his work, or writing down the study notes, he was just drawing a car, so I was like ok , *you can draw a circuit powering those lightbulbs because that's what we were doing.. Na* so its just some students who are just---its hard****

*Initial vs Post prac belifs.*

*I think in some ways it's the same. I know the different strategies, like doing practical activities, keep mixing up the lesson into different activities but I still have that now from when I started. The engagement with when students just blatantly refuse to do their work, that's probably … I probably didn't think a lot about it before I went to placement but now it showed me that its hard to get some students engaged but with the practical work,* *like y8 some of the students weren't engaged but when we did practical work there was a group with 2 girls, they were just.. made a catapult, they were pretty hesitant at the start but they made a catapult and they came third out of the class. Giving them a bit of support *good job* and that helped, but I think it was the hands-on nature of it rather than writing down notes.*

*So my beliefs are almost the same. I suppose it really highlighted to break up, do multiple strategies per lesson, to meet the learning need of each student. Try and cover as many learning styles as possible. Also I suppose really knowing your students. In 4 weeks I didn't, I got to know them a little bit but not to an extent you would in a year. I think if you knew your students and knew what they were interested in and even their learning difficulties or like y7 I was told was a low literacy class so then I could aim the lesson at the lesson they could achieve at. I think that's important with engagement, that you know what level they can achieve at and target the lesson at that level. Because that y8 when they sense the lesson too hard they just sort of gave up a bit so I think the strategies are important but you also have to know your students. And you have got to target the lesson to that level so they can achieve it.*

**5. Which motivation strategy did you think was the most effective one for motivating science students during your professional experience placements? Can you explain what made it effective?**

I'd like to say hands on practical work, but I stil found students that were mocking around and I don't know whether that's more discipline, you got to have some classroom management. I need to be a bit stronger with my classroom management to get them to egage. Because I feel like sometimes you can have really nice lessons but if you don't have classroom management then if one student is not engaged it can kind of like spread.

So practical is really good. I feel like even just doing comprehension sheets, they were engaged in that but I don't know whether that's because if they're all sitting down, you sorta have a presence and can walk around the room and make sure they're on task. Whereas with practical, they're all in their groups and you have got to try and get between each group, there's always going to be a group that's not near you so they might go off task.

**Least effective**

*I suppose reading and comprehension was least effective, but I didn't scaffold the answers as well. I think video comprehension hooks them in with the video.*

*Just based on the unit, y10, the universe, it was a lot harder to do hands on activities. So it was a lot of note taking videos answering questions, that sort of thing, so that didn't seem to engage them as much.*
*I think it really depends on the year and the age.*

**Is there any advice you would give PSTs?**

*I think just use the prac as a way of testing different learning strategies. Because you don't have anything to lose. It's a good way to test different things. I think just try different ways of learning and I suppose mix it up, don't do the same thing, break up the lesson into threes, at least 3 sections, try and go outside. I suppose I was a little bit worried going outside with the class just because it's harder to control them in a big open area, plus you've got people, I feel more observed because other people in the school can see whereas if you are just in the classroom it's not as .....So yea go outside, take different opportunities , go to different spots during placement and go to different classes.*

*I went to English and Maths, I followed my y8 students to English and Maths just to observe them. It was mainly to see the teacher… because it was a bit of a challenging class. My supervising teacher suggested to go and follow them to Maths because one of the teachers was having trouble with them in Math and I followed them. I went to English as well. That was good just to see how they interact and see different teachers, different strategies those teachers use.*
***Another advice?***

*Going outside, videos. Bill Nye videos are good. Even when I did it I think they were like aww this is a bit silly. Because it was silly, they laughed at it. They watched the one on cells.*

*I think it's one of those thing you have to give it a go and be open and depending on what school you go to I think it will vary a bit. And just know your students. I didn't really get access to central so I couldn't go through and learn about each student and what their level was, I just heard from teachers and supervising teacher about certain students. I wouldn't have been good to have more access or take a look at the level where the students are or even talk to the supervising teacher.*

*Take advice. When your supervising teacher suggests things just go with it because they are the ones that know the students the best. They know their academic level but also they know any problems they have had at home or whether they are always suspended. You can see if one student that's not normally there is there, he might pull in all the other students that normally engage but then they don't engage as well in that lesson. But then they don't turn up all the time so you can't organize a seating plan when they are not always there.*

*I feel like with the science judges that hasn't changed very much from when I started to now. I feel like I can't give that much advice because I feel like us prac students starting in science* *would probably know strategies because we have been in labs we have experienced pracs and writing down notes and things like hands on activities that we sort of know that area.*

*I think the biggest thing in prac is more the behavior management and knowing the students and engaging with them and taking opportunities.*

***We have come to the end of this interview***

**Semi-structured interview of the supervising teachers (RQ 1, RQ2)**

**Aim: Strategies that the PSTs used to motivate science students during their professional experience placement**

**Name: LORNA**

**Time: 1:00PM**

**November 29th 2019**

1. **What strategies did you notice Elsa use to motivate science students during her professional Ex placement?**
   - *Getting to know their names. You talk about engagement and getting the kids involved in the lesson you have to know their names; really well too to get them to have that engagement.*
   - *Giving them encouragement, positive feedback and knowing the student's names.*

*<u>Example of positive feedback:</u>*

When she has asked a question and the students put their hands up and before getting one of the students to answer it she would say *t**hanks** very much …..whatever the students name was, can you answer the question for us?* and that motivated the students **yes**

**<u>Can you give me an example of a time when any of those strategies did not work?</u>**

*she had a strategy where it was one, two, three just to get the kids to be quiet and turn their attention back to her so she could move on with the lesson but it worked for a little bit but if you over use it, it loses its effectiveness.so that's definitely one, the 1 2 3 counting.*

*That was probably the main one.*

***<u>Why did you think the strategy did not work?</u>***

*Overuse*

**<u>Were there any factors that influenced the strategies she used to motivate students?</u>**

*Observing another teacher definitely helped. Picking up their strategies and utilizing them.*

*Consistency is definitely the key with any strategy.*

*And being firm too.*

*Observing other teachers is probably the main one.*

*So she followed one particular class into another KLA and noticed that some of the strategies used there were similar to hers although the teacher is a bit more firm in it. Yup just observing other peoples' lessons definitely helps.*

**<u>How have Elsa's strategies for motivating science students changed during here professional experience placement?</u>**

*It has definitely been more consistent and realizing that you need that consistency to make them effective.*

*Being firm. Probably finding her teacher's voice to make them to firm.*

***<u>Can you explain what being firm means?</u>***

*Just reiterating the instructions, repeating them. Making sure the students understood those instructions and what she was asking them to do. Not yelling at them but being firm in her instructions. Not just asking the questions but making sure it was a *you need to do this now conversation**

**What are the types of experiences and guidance have you provided the pre-service teacher on how to motivate science students?**

*Conversations in the staffroom with other teachers in science.*

*Seeing other teachers on the staff put in work.*

*Visiting other teachers in other faculties and watching their lessons just to get a bit of experience and just to see…. Every teacher's got their own style I guess and maybe you need to find what works for you. There are different ways to motivate students. Just because it worked for me doesn't mean that it was going to work for Elsa. That was the most important part for her.* **<u>Is there any advice about how to motivate science students you would give to PSTs preparing to teacher science?</u>**

- *Just being firm, I think. Just being firm and consistent is the key.*
- *Find a connection with the kids. You can't just get out there and yell at them all the time, it really doesn't work. So being consistent and knowing your students is going to be key. A lot of them…they need that consistency.*

*When you say find a connection what do you mean?*

*Finding a connection to them for sure. Finding out what they are interested in in and outside of school. What their family structure is like, their favorite footy team, what they do over the weekend. Find a connection that isn't academic based and using that to motivate them.*

*Thank you very much Lorna for this interview*

**Terry and Rebecca collated interviews**

**<u>Semi-Structured Interviews</u>**

**<u>Duration: 45 minutes -1hr</u>**

**Interview One of PSTs before their professional experience placements.**

**Goal: To find out about the pre-service teacher espouse theories about student motivation.**

**Participant #3:**

**Program: Bachelor of Teaching Secondary science**

**Year: 3rd Year (Male)**

*Theme One: How are espoused theories and theories -in-use of motivation are developing during their professional experience placements? (Main Research Question, RQ1, RQ4)*

1. Can you tell me about your experiences that led you to develop your own ideas about *motivating your science students?*

*I guess for myself, I am currently a fulltime swimming coach so I guess my role in that is to make sure I have a good rapport with the kids and usually if I have a good rapport with the kids, the kids are generally a little more motivated, or maybe talk to you a bit more or whatever it might be. They generally are a little bit more engaged in what you're trying to deliver so I suppose my number one stance going into placement which is always tough trying to get the kids involved in what you want to do; having their teacher all year, is make sure I develop a good rapport with all my students and from there probably make more of an assessment after the first few days.*

***I am in my 5$^{th}$*** *year at uni but this will be my second prac I have been on so the first prac I went on I had a really good supervising teacher and from him I took the importance of making sure that media that I am giving the kids, all the information I am giving the kids is coming from a wide range of media and I think that just sort of keeps the kids stimulated and wanting to learn rather than just the same old boring way of doing things I guess, whether that be booking the laptops for a lesson or what not.*

**And when you say media, can you clarify that a bit?**

*That would be things like laptops or experiments or maybe some group discussion; delivering content to the kids in different ways.*

2. *Are there any other experiences that helped you develop your ideas for motivating science students? Can you explain that?*

*Not really, just from my last prac as I said, I just got that from my supervising teacher, but I also spent a bit of time about in other classrooms just watching how the other teachers taught as well. As I said I am only on my second prac now so I am really; cause its part of my job I feel like I am really good at dealing with kids but learning the different strategies for classrooms and stuff like that I guess I am pretty fresh.*

***3.*** Have you experienced anything during your studies that has led you to understanding how to motivate science students? Can you explain that?

*Yes, I guess there are a fair couple of courses that have sort of doubled up on each other, I personally would think, but one that comes to mind was like a *I forgot the name of the course* but it was basically like a multimedia course that basically had you doing lots of assignments and stuff. We had to develop lesson plans and stuff by using things *I forgot the name of this website* just different ways of delivering the content to the kids. So there has been a couple of courses but as I said I work fulltime, I am not the greatest, not the most academic student but there have been a few courses.*

*Theme Two: Factors influencing how espoused theories are enacted during the professional experience placements (RQ1, RQ2, RQ3, RQ4)*

1. What strategies do you think you will use to motivate science students when you go out on your professional experience placement?

*Again, having a good rapport with them and delivering content that they are going to be excited to get involved in. So maybe it's time to do pracs that are a little more fun or stimulating and something that is of the same topic that is fun.*

*Try and deliver a wide range of things especially in practical lessons not doing a prac that just ticks of the dot point on the syllabus but doing something that might be more fun, more engaging to the students.*

And when you say fun and engaging what sort of activities did you have in mind?

*Well I did a really good prac with some year 7s students on my last placement which was a drop lesson that we did. So we obviously looked at physics and stuff and looked at crample zones of cars and put that in a practical context where the kids were given a cup, cotton balls, straws,* *masking tape and lollipop sticks and they all had to design a contraption that would protect the egg while it was going to be dropped from a certain height. It became a bit of a challenge for them to see who could their eggs to survive the longest from certain heights.*

2. How effective do you think those strategies will be? Why do you say that?

*I would like to think that they would be as effective. Obviously, I haven't been to the school yet or met anyone from the school so I am not sure how they might approach their lessons as opposed to the other school which was pretty relaxed, I thought. It was a really relaxed sort of learning environment which I actually really enjoyed. But as I said I have not been out there yet but I would expect my way of doing things to be as effective-again rapport with the students.*

3. Is there anything that influenced why you will choose those particular strategies to motivate science students during your professional experience placement? Can you explain that?

Probably just my experience with school. Being a student, I guess I quite enjoyed my time at school but I really thrived in high energy classrooms where the teachers were not so authoritative but more created that sore of welcoming environment; a few jokes and the class would laugh, I shouldn't be using the term relaxed environment but that's sort of what I'm trying to bring across.

How do you think being on your professional experience placement will help you develop your ideas for how to motivate science students?

*I think as well, and I have said this multiple times but being very fresh to the teaching environment as well only having done one placement, I am pretty excited to get to see how other teachers teach and how other teachers motivate their students and then maybe picking some from other teachers and eventually developing my own ways to motivate students. I think again for me I would just like to keep my mind and ideas broad and open to suggestions, ideas that sort of thing.*

Thank you very much. We have come to the end of the first interview

**<u>Participant 3C Terry</u>**

**<u>Bachelor of teaching secondary science</u>**

**Duration: 20 Minutes**

**Interview Two of PST during their professional experience placements**

**Goal: To find out how PSTs are using their strategies to motivate science students (RQ1, RQ2. RQ3, RQ4)**

1. **First of all, how's it going?**

*Pretty good, I feel like I am getting more into a rhythm the more I complete my prac. First week and the second week were not daunting but just trying to get every kids name learnt and getting the trust and rapport with the kids as well. Finding out their interests and then by the time you get into the 3rd week and 4th week its getting easier I suppose. I am just getting a roll on with my lesson content and I'll know what I'm doing. Probably more organized as well which is always helpful.*

2. **Can you tell me about a science lesson when you felt that you really motivated the students?**

*So yesterday we've been carrying on with y10 with the global environment. At the moment we 're looking at things such as cyclones tsunamis earthquakes and volcanoes. I have been trying to use as much different multimedia as I can. Just diagrams, videos a bit of stuff, just trying to give them information in many different ways as possible. I knew that I had engaged those kids or motivated those kids because there wasn't one kid with a phone out, they were all listening to me while I was talking and there was a lot of group discussion going on. The kids asking me questions, just bouncing off me, so I knew I had them engaged or at least interested in what we were learning.*

**b. Can you tell me of a lesson where you felt like you did not motivate the students?**

*Yesterday for sure, the 3rd class that you sat on. We are doing waves and communication at the moment which some people might be interested in the physics whereas others are not so much.*

***Why do you think that some were interested, and some weren't?***

*I think with things like biology or things like the volcanoes and stuff it's more of a known thing to them, so they are more interested to know. So, they are more interested to earn about things they have some sort of understanding about. Whereas things like transverse waves and the Am spectrum, it just doesn't seem to draw the kids as much. We were doing a lesson, a summary sheet on everything we've done so far, so we were doing transverse waves, compression waves,* *what they carry a little bit on the AM spectrum as well, and admittedly I caught them at the end of the day so it was like period 6 end of the day they were all sort of keen to get out of here. But I just really struggled with phone use and getting the answers down without me actually having to read the answers out loud and go through them with the sheet. So, they still achieved what I wanted them to do just not in a way that I wanted them to do it. I wanted them to try and revise on what they knew not necessarily me force feeding them the answer.*

***What are the main strategies you have been using to motivate science students?***

*Just trying to get the class involved or interested in what I am talking about and again through the use of different methods such as videos, the kahoot app which is great, trying to stimulate them in as many different ways as possible but I'm trying to engage all the kids that learn differently. Sometimes lessons writing is great; just taking notes, but these kids don't really learn that way need some more visual stuff so I just try to account for every different type of learning in my classroom.*

3. **On a scale of 1-10 with 10 being the highest rating, how would you rate the effectiveness of strategies you have mentioned? Why would you give that score?**

*Videos: I think probably a 7 if its backed up with something. If I have generated a worksheet or something like a Bill Nye lesson where they are taking notes from what they have seen in the video and they have that too then recount them later, I think that this video is extremely important way of learning or extremely useful way of learning.*

*Kahoots/games: Kahoots, I am going to say maybe…. Again, some kids really like that competitiveness and trying to be the best in the class. It also is great for exam prep because the kids know they're going to get the answers right or wrong, they have seen it. But again, some kids get their phone out they get distracted, they start looking at other things like soral media. It's a great resource but its not the best.*

*Stimulating in other ways: Visual, using diagrams and using models and stuff like that. Probably a 7, especially physical models and getting things such as light boxes out with the class around you and showing how the light bends or refracts. (kind of like demonstration, that's right)*

*How do you think demonstration would help in motivating the students?*

*I think demonstration or experimentation is what science is all about isn't it? I think its probably the most useful tool, because the kids get smashed with the theory but then they get to put it into* *practice and play around and see actually how that works. So they know the theory behind it , lets have a look at it in a practical sense.*

*Taking down notes: I probably would give it a 7 again to be honest. Only because I know that some kids especially one of the young boys in the last class, he takes notes and I know that he recounts on it because I asked him about that because he did such a good job on his yearly exam; he got the top mark of the class, so he learns that way whereas other kids don't necessarily learn from taking notes. They would write it down, they would look at it again.*

4. **Are the motivation strategies you are using now different from the ideas you perceived before our professional experience placement? Can you explain that?**

*I don't think they are different, but I think that I have a better understanding of what works and what doesn't. It's always great to have your own ideas of what you are going to do as a preservice teacher that hasn't been on placement for 2 years. I am going to uni every day, being told what I should be doing and it doesn't necessarily work like that in the classroom, so its good to know the strategies, now what motivates kids but then put it into a practical sense in the classroom and that varies from class to class;y7 to y10 which is different from year 9. I think that I have made changes to what I was going to do but I have stayed on the same track.*

*What has led you to making those changes?*

*Mostly student behaviour. Just classroom management, keeping the kids moving, getting them to do the work, or at least maybe I have lowered my expectations of what I want them to achieve so it's not *let's get through this in a lesson, let's get 3 key points and if I tick those 3 key points, sweet, we're good* It's not trying to over teach the kids I guess.*

**Which strategy has been the most effective?**

*Probably stuff I did on my last prac*

*Doing things that involve a whole class situation, splitting of nucleus and stuff like that so you know the kids will stand around the room with bits of paper in their hand and if you threw it at someone and you got hit you have to throw another bit of paper. It's was really fun, and the kids got a really good idea of how it works. As ai said It's that theory component and then find exciting ways to demonstrate it practically.*

*So the strategy would be demonstration as the most effective one; I believe so. I think that showing them something physically after you talked about something theoretically is the thing that I found the best way to get the kids to understand it or get themselves involved in what I am trying to bring across.*

***Least effective strategy***

*Least effective has been completing tasks from a workbook. I think maybe they've just had too much of it at certain times. So they get the workbook and they go *not again, can we do a prac, can we do something different* But then it's trying to remind them that we've got to get thought his stuff before we can get to the eye dissection, before we can get to the other pracs in the course because you need to have that theory understanding before we put it in a practical sense.*

*I found the workbook to be a bit dry and that's from me personally which might impact the class. If I am not super excited about it maybe that relates through to the kids, at least they can sense it.*

**5. Can you describe a lesson where you successfully used a strategy/strategy to motivate science students?**

*Yesterday (Monday) with year 10*

*Period 3 (morning-afternoon) (straight after recess)*

*We looked at earthquakes and tsunamis. We did a similar slideshow to the one I sent you from last week. So, they had lots of images, a bit of writing, I made them take notes rather than filling out a worksheet and a lot of videos as well. There were stacks of questions going on, there were stacks of group discussion going on which was fantastic but* common guys listen to what I have to say. They were all talking about what we were learning about, going off about the 2004 boxing day tsunami and all that sort of stuff. Then a little bit of research in*
*the send *Guys show me some interesting facts, get your phone out, show me some interesting facts, how many buildings were destroyed, how much money went into that to rebuild the city* and things like that. Because they took to that so well, we're going to do a research task in the library on Friday, because they were all super excited about it.*

**Why do you think using that strategy/those strategies were successful?**

*I think the group discussion made them challenge each other to find out new facts or at least test each other on the cool stuff they knew. It was really interesting to see them bounce off each other and even some kids, there was this one young bloke who is challenging to get started but once he is started he is ok but most of the time he doesn't wana pull his book out of his bag, just not interested at all. But *hey sir check this out, I found this on my phone, I* *found this fact* so it's just again that group discussion—smash them with videos diagrams, this stuff is cool, plus I am bouncing around the classroom.*

**7. Can you describe a lesson when you used a strategy or some strategies to motivate science students unsuccessfully?**

*Yea definitely,*

*Y9*

*Period 4 Monday*

*Topic: waves and communication*

*It was what I was talking about just before Going through the workbook personally I think it's a fantastic worksheet because it's a great way of recapping everything they've done. However, they didn't take to it as well as they did to the Kahoots.*

***Why not?***

*Again just that constant getting through the workbook *here's the workbook* *oh not the workbook again* They needed a different stimulus which they got at the end of the lesson which then everyone was challenging each other and being competitive with the quiz and trying to get the lollies, the prizes and putting their theoretical knowledge into practice in testing.*

*Yesterday was an eye opener for me just to make sure that they are continually getting content through different stimulus, not the same thing. Just because we have to get through this doesn't mean you can't find other ways to show them that.*

**8. How has the guidance from you cooperating teacher and science education subject educators helped you in motivating science students?**

My supervising teacher has been really helpful. She has given me plenty of feedback post lesson. Mostly just trying to keep kids that don't want to work on track. So going around trying to maybe give them a couple answers or point them in the right direction, sitting with them. Its more her motivational strategies have been more toward the kids that don't necessarily want to do much which is also reflective in the lessons I get supervised from her as well. So it's a tough one because you're this guy that's coming in as a PST for 4 weeks and the kids know that and they just go *heyyy party time ---we're on we're on !!!*
So you have got one sense, I know this is the way kids acted for the last 12 months, I've got my supervising teacher who is assessing what I'm doing which I then need to make sure I am hitting. But then giving me the motivational strategies in between.
As I said it hasn't been directed at the kids that want to work, they're also the kids I've developed a rapport with most quickly, its more directed at the kids who haven't been motivated to work.

**Participant: Terry**

**Duration: 15 mins 37 seconds**

**Programme: Bachelor Teaching Secondary science. (5th Year in the program)**

**Interview Three of PSTs after their professional experience placements**

**Goal: To find out whether the pre-service teachers' perceptions about student motivation before their professional experience placements changed during their professional experience placements (RQ1, RQ2, Main research question)**

**How are you going?**

*Yea good.*

1. **Is it possible to remind me of some of the strategies you used to motivate science students during your prac?**

*Again, it was trying to use as many different technologies as I could and different stimulus such as PowerPoint presentations, videos, models etc to try and account for every type of style of learning of the kids in my classroom. It even gets as boring as taking notes.*

2. **Can you describe a lesson where you successfully used a strategy or some strategies to motivate science students?**

*During my time with year 9, we have been looking at waves and communication which is a Physics topic from Physical World, stage 5.The topic is quite boring and dry, especially at this time of year where the kids a little bit disengaged but there's been a really couple of fun things we've done in that. We've talked about reflection and refraction and moved that to a whole practical sense with light boxes. The way I attacked it was I did some theory, half a lesson of theory, *alright guys let's get the light boxes out, send some beams of light through the prisms, glass slabs on the mirrors and see how this reacts in a practical sense. That way I was giving the kids content, they were writing down content, they saw some videos and then they saw that practical side.*

*Time of day?*

*It's was a bit of both. Probably one in the morning, one in the middle of the day. During the afternoon classes with year 9, we made a model of an eyeball because today we dissected an eyeball which was pretty cool, so the kids were really excited about that.*

*A little bit of experience from the time I was on placement was, the kids period 6, it was like bashing your hear against a brick wall, trying to get content out of them. So, I was trying to give them other things that would excite them to learn rather than giving them something that wasn't… a bit boring, I suppose.*

***Why do you think that using the aforementioned strategies were successful?***

*I think that in the class group I was given y9,  there were a couple of students in the class that were top of the class very close to moving to the top stream, not quite there, so those guys happy to work on their own and really keen to take down theory. Then I had a few kids in the class that didn't like any theory but worked really well with prac so again trying to accommodate all those kids in my lesson to ensure that everyone's getting an idea of the concept*

3. **Was there anything that influenced why you chose those particular strategies to motivate science students? Can you explain that?**

*Mostly from trial and error. On our last interview and the last time you came to observe my lessons, it was very much a theory driven lesson from memory. Yes it was good and stuff like that does need to be done to get some content out there and move through the syllabus's dot points. But it just wasn't working with that class, so I had to develop ways to try and engage the kids that were really disengaged.*

***Why wasn't it working at the time?***

*Because I think that driving content into kids that are maybe *I don't like using the term* lower ability but driving content into those kids that are lower ability and a little bit resistant to engaging in work, it was my job then to fin strategies to push them into the direction; we're all going down the same path which is where I brought in some videos, pracs and some diagrams and some physical demonstrations.*

**Was there anything that influenced why you chose those strategies?**

*Probably personal interest in it as well. I found that during my time on prac the lessons that I was going pumped up and was keen to teach, the kids reacted to that a lot better. The lesson I went in there---and sometimes being a prac student it means being disorganized and throwing something together at the last minute, that is something a bit content driven, worksheet and that made a big impact on the lesson as well.*

**4. Can you describe a lesson when you used a strategy or some strategies to motivate science students that did not work?**

*Again working through tat workbook that I've previously talked about. Even though that's what the school wanted me doing, and that's what the other teachers were doing, I*

*personally found that the kids were coming to lessons and being like *ahh not again, not the same workbook!!* Which again reinforces my ideology that they need to be given something different or at least different stimulus to keep them motivated to continue their learning.*

***Most effective strategy:***

*My most effective strategy was probably a bit of group work and group discussion. My favourite thing to do was to slit the students off into different groups and give them a bit of a team building researching sort of task where they had to come up with certain points and certain things I've asked them to do and made it into a bit of a game. I think that was really good.*

*Why was the group work/discussion most effective?*

*I think the kids in the class all had great friendships. One thing I did pick up was that they all worked really well collaboratively. I also think that although mobile phones sometimes can be a massive distraction, I think they can be such an asset in the classroom as well. They all love their computer games, they love their laptops, they love their phones. Why not find a* *way that we can in cooperate that into class in a positive sense. *So yes lets split off into groups; I want you guys to find 10 facts, use your phones, get into it. You have 15 minutes and then we share ideas/ points with the class.* I found that to be quite effective.*

***Least effective strategy***

*Again, just content driven. Giving them content without giving them a model or something else to really emphasize that point and bring them into what I'm doing*

**How has being on your professional experience placement helped you understand how to motivate science students?**

*I think that during my time on placement I was bless and also cursed with some very difficult classes and some extremely challenging kids. As I said that was a curse because you're an education student coming in to a prac where you are there four weeks, the kids know you're there for 4 weeks, so it is a little bit challenging because they are trying to test you. But at the same time it's the best opportunity that I'm going to get as a preservice teacher to learn and to in cooperate some strategies to see whether I can get the kids involved and motivated to do what I want them to do.*

*As I said, getting those difficult kids, and trailing different strategies with them and seeing what works and then obviously if that strategy didn't work, I don't bring it back into my lesson. My supervising teacher was quite critical of my lessons which I think me personally I react well to some constructive criticism. It was interesting to hear her points about what worked what didn't and I think most of the time we both were on the same page anyway.*

**How did your initial beliefs about motivating science students compare with your motivational beliefs during and after your professional experience placements?**

*Before prac I knew that I wanted to try and bring in a large amount of teaching resources into my lessons. In saying that my lessons weren't super structured with a bit of everything in them, they were maybe a theory lesson with a fun lesson, a prac lesson. Whereas throughout placement I learnt to try and in cooperate all those sorts of things into the one, I think it made me a bit more organized. After the experience of the first couple weeks I've definitively changed my mindset on that*

**Do you think your beliefs about how to motivate science students have changed post prac**

*I think it's changed. Although I am still heading down the same path of how I want to teach, what I want to use as resources, but I definitely think that my approach has changed.*

**How do you think it has changed?**

*Again just trying to accommodate many teaching abilities and not Structure a lesson for what I think is going to work and forget about all the kids that don't learn that way. So me personally, I think that technology is such a useful tool with kids in this age. They are so driven by that sort of stuff that it needs to be incorporated in the lessons.*

***Can you explain that?***
*Anything from videos to the kahoots, which was the quiz game that I showed you. Puzzle games online where they have to get like diagrams like eyes and the features; that sort of thing.*
*All that stuff is a useful resource but it's not the way to solve problems. It shouldn't be overused.*

**Is there any advice you would give PSTs?**

*The biggest take home for me, I've had a lot of experience working with kids, but the kids have to trust you and you have to have a rapport with them.*
*My advice would be not to walk in there and demand things from them, I think that you need to get to know them, know the kids, get to know how they learn, get to know their interests, which doesn't take that long. Then find ways you can motivate the students through that. So its gaining the trust of the students is important.*
*U=*
*I think being able to take constructive criticism is super important. Unfortunately guess what you have been at uni for a couple of years you don't know everything. Your supervising teacher most of the time has been teaching for a while so take their advice on board. Always keep an open mind and look for new ways, ask questions and find new ways to stimulate the kids, motivate the kids, different strategies you can use in the classroom, different ideas, just try and pull as much in as you can. So don't be closed off trying to be smart when you're on placement, go and watch maths, go and watch history and just be willing to learn while you're on placement.*

***We have come to the end of this interview***

**<u>Semi-structured interview of the cooperating teachers? (RQ 1, RQ2)</u>**

**<u>Aim: Strategies that the PSTs used to motivate science students during their professional experience placement</u>**

**<u>Code Name: REBECCA</u>**

**<u>Time: 2 pm</u>**

**<u>Temperature for the Day: 34 degrees</u>**

**<u>November 5 2019</u>**

1. **What strategies did you notice Terry use to motivate science students during her professional Ex placement?**

*At this time of the term it's obviously been quite difficult. He has done really well with bringing in different activities, games prizes, more interesting lesson plans especially being this time. A lot of experiments, a lot of hands-on activities rather than just theory based so it seems to be working at the moment.*

**Can you give me an example of a time when any of those strategies worked?**

*For example in in cooperating the Kahoot quizzes into some of his lessons so finding different ways to either revise what's been learnt in the previous lesson or to enforce the information that's being taught during a current lesson. Throwing those little five minute kahoot quizzes, the kids see it as more of a game than just as going over the same questions again, and having the prizes involved seem to get even those quiet kids who don't really get themselves involved, they are getting in their answers done. Even if its not written work as such they've still been able to answer questions in more of a game situation, so a bit more competitive.*

***How have the prizes contributed to the students being motivated?***

*Some things would do anything for a lolly. Some of them, they may be the type of kids that they think playing kahoots or doing some of these activities can be a bit lame is probably a way to put it. Yet for some if they know there is a possible prize on offer to get first place, they are actually more likely to try that little bit more.*

*We have tried it before where if they think there's a prize, they do give it a go. If they think there's no prizes, they might kind of lag back a little bit. Sometimes they do still get involved but those little things to encourage, just that little bit further seem to work quite well with some of these kids.*

***What about experiments, how have they contributed to motivating students?***

*So for experiments we have done so far—Year 9 for example we're looking at light, reflection and refraction. They have been able to get up and have a look at how light beams reflect off a mirror, how they work through different lenses, so just being able to get up and be a bit more hands on with things. The y7 class for example, have been able to get up and actually have a look at hands on different invertebrates rather than just seeing them on a picture on a board, being able to get up and actually see the physical examples.*

*Y10 was probably a little bit harder. For the course that was there, their experiments weren't quite as easy to come by. But he tried to in cooperate more activities as such rather than hands on experiments for the topics that were being taught for them.*

**<u>Can you give me an example of a time when any of those strategies did not work?</u>**

*I think one of the experiments, it was done with the y 9 group. It was a Friday afternoon, later lesson, really not motivated to get themselves moving so even that opportunity to get up for them was too hard. The topic was light, they were looking at reflection in things and they did eventually get themselves into it bit it probably fell a little bit flatter than what he was hoping at the time. I think that was primarily due to the timing of the experiment, Friday after lunch, hot day, doing think they were really motivated to do anything that day. Yea they get a little bit tired.*

**Can you give me an example of one successful lesson that you remembered where Terry really motivated the science students?**

*It was the same class, y9, for example the very end of a lesson, they'd actually been doing really well, we got down some theory. I say really well but that particular class even a little bit of work is a really good lesson. Towards the end they were starting to just wear a little bit thin and that's where he brought the cahoots in to kind of go through some of the information that he'd just done. 80% of the class got their phones out, logged straight in, got into playing, joked around. They were all very competitive against each other and it really seemed to motivate them back in the lesson that they were starting to wind back from.*

**Were there any factors that influenced the strategies Terry used to motivate students?**

*One of the main problems is the time of year at the moment. We have needed to, the kids have all finished their yearly exams, in their mind they think that school after they finish their test doesn't matter anymore.  So those last five weeks of term, you're looking at the very last few weeks in term 4, they're all done and dusted, they think they're finished, so needing that extra motivation to try and find different ways to get them involved, knowing that they still need to finish those topics has made it really quite difficult for him. Actually having to come up with new strategies to go ok.*how can I get these kids to at least participate a little bit in a lesson?* Has really been quite difficult for him. Whereas normally throughout they year cahoots wouldn't be something that we be using/ strategy unless you are just about to do a test. But at this time of year I think* *that it has been a positive one to try and get the kids a little more motivated, involved in the lesson.*

**Were there any other factors you can think of?**

*Probably a little bit of encouragement across the faulty as well. We are a very collaborative faculty, everybody likes to talk about what we just done, what has worked well, so I think those factors seem to involve as well because if you have got one idea of what you're going to do in a lesson and somebody else has just come back from a lesson and said I did this, and it worked really well. Then your strategies change almost instantly and you think, well that actually sound s like a better idea than what I was about to do. So that idea of talking and collaborating with those around you to try and work out what might work better to do the same thing. Dotpoint definitely plays a big part in how you plan your lessons in here.*

**How have Terry's strategies for motivating science students changed during here professional experience placement?**

*I think he is expanding a little bit, finding different ways, doing a little bit of research. He knows the kids better now. When you first come, 4 weeks is such a short placement that in those first 2 weeks trying to get to know what the students are like, trying to get to work out what works and as the placements worked on he's found that what works for year 9 particularly doesn't* *necessarily work for the y10 group. So getting to know those kids a little bit differently as it was going on.*

***Can you explain what you mean by getting to know the students?***

*For example, the y9 class are really mixed ability group. We've got some who have very low literacy and numeracy skills and then we've got others who are borderline A stream, they are really quite smart kids. So having to look at the strategies within that room is very different from the year 10 where the y10s are all kinda bunched middle ability, group of kids who are very vocal, likes to and participates quite a lot. Compare that to the y9s where part of the class wants to realllky join in and and get vocal, part of the class wants to just get on with their own work because the tops of the class are more than just ahpppy to.. just give me the work and I'll get it done. And then that lower group who need a lot of encouragement and a lot mopre assistance to get things done. SO having to look at these starategies across, you cant use the same ones for one class and use that walk into the next room and then do the same thing. It's just having to just learn who is in the room and who seems to do better at it. For example, the y9s are great with kahoot, y10 got bored with them quickly and he had to think of something different to do with that group.*

*And then having to look at that y 7 lesson, for example again a completely different type of quiz for them but realizing what type of kids they are in that room. Means he can do that rather than the kahoot, but that wouldn't have worked with the y9 group. They would have lost interest in that very quickly. As I have said there are some kids in there who lose interest very quickly on a lot of things. It needs to be hard and fast for them to want to be involved. They have the competitive nature but I think it needs to be quick short questions and a lot of them don't like to write very much. So if they've had to write answers down that automatically indicates to them* *that *no that's going to be too hard, I don't want to do that* Whereas doing it on an app and quickly pressing a color on their phone is something they are more likely to do. In their head they go *I can do that, that's easy, I don't need to really work to get a result**

**What are the types of experiences and guidance have you provided Terry on how to motivate science students?**

*We have actually gotten him involved with not just the science faculty. We tried to get him to explore other faculties as well to see how they motivate the same groups of kids. For example heading off to Geography he can see what that teacher does with the exact same y9 class for example. Kinda give you a little bit more of an idea of what the students themselves are like which can help you expand motivation. Then being able to go through and observe all the science teachers in any of their year groups whether it be from year 7 and all the way throughout year 11 and see different strategies that they're all using as well. We've all got very different ways of teaching and it's not till yourself get involved you start to actually work out what works but the more people you can observe and see how they handle behavioral management for example and motivate kids in order to prevent negative behaviors in the classroom can be a really difficult task. But getting the opportunity to see other [people do it and then go *ok that, I might try that next time and see if I can get kids to be motivated. So try to expand who we are seeing and not just seeing the three classes that he is currently in.*

*He did come along to one of our excursions a couple weeks ago which again was another way to show even for seniors, sometimes at this time of year even the seniors are becoming disengaged. They themselves cant wait till the holidays. Y11 is a very long year for some of them, they feel like they just need their break. But gaining that opportunity to take him on an excursion and see* *different ways we can motivate them outside of the classroom and try to get them involved in the topics that they currently trying to learn, where they are quickly trying to push through at a time of year where they really don't want to do anything. When you look at the junior classes they're a;;l kind of winding down bit y11 are having to restart being their first HSC module. So we have had to really try getting that motivation level back up quite quickly. So doing things such as excursions or incursions where we walk around the school and finding other ways to participate and learn the topic that's required I think that's a really positive thing for him to have found out.*

**<u>Is there any advice about how to motivate science students you would give to PSTs preparing to teacher science?</u>**

*Number one is really get to know your kids/ get to know them. Don't think that you need to plan a lesson because that's what… if you're looking specifically at content, you are not necessarily going to get the kids involved. You can know your content all you like but if you don't know the kids and you don't know how they are going to learn; you are never going to get that engagement that you need in order to get that content across.*

*I think one of the first things in PST that I worked out with the PSTs that I have had recently id once they get to know their class a little bit better, know what gets them interested, find out what interests them; even what interests them outside the school. You are going to start to get to them better; What are their extra curricular activities, what do they like to do, what do they interested* *in.Because I am interested in science but it's not all I am interested in. It's that ideas of having that relationship with them that you go ok well I'm interested in who you are, now let's use that to try and find ways to help you learn so can you blend in what they know from outside into your lessons a little bit better.*

*Examples could be I know that one of my y10 kids is very big on motorbike riding. He absolutely loves to ride his dirt bike. Involving that into my motion topic drove him in. he is a very disengaged y10 kid , he doesn't want to be at school , he is signing out at the end of the year , he has gotten an apprenticeship, he is out of here. So to start the year, he didn't want to do it, as soon as I knew what his interests were I found new ways to pull him into the lesson. I was still giving the same content but I might change the questions a little bit. It doesn't necessarily mean its going to be relevant to everybody else in the room but you try to just pick little things in a lesson or in a topic that everybody is getting just a little bit of what they know and what they understand because they make it relevant to their life. Alot of kids these days think that science isn't relevant, I am not going to do science when I leave so what's the point? But once they understand that science is relevant always you just got to find where its relevant to each student. Once you get to know your kids a little but better you can usually start to work out what's going to fit for each one.*

*Xplore different ways, don't try limiting yourself. Ask around. If you've got one particular supervising teacher, they are not everything to you, ask around the faulty ask around the school. Have a look on social media. I am all for the chat groups on social media*
*Social media can be a really big resource for us teachers, I am on every chatgroup on Facebook that I can find.....because you can get so many ideas from outside. Its such a big world out there*

*of teachers, they've all got such different ideas of ways to do things so get out there and try and work out different ways to do what you like to do or find different things to get kids involved.*