PRESERVICE TEACHERS' PERCEPTIONS OF HOW TO INCREASE THEIR STUDENTS' LONG-TERM INTEREST IN SCIENCE

by

Davis Leonard Kevin Jean-Baptiste

Cert Teaching(UWI-Barbados), B. Ed(HONS)(UWI-Barbados), M.P.M (UCI-Mexico)

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Principal Supervisor: Associate Professor David Palmer

Associate Supervisor: Dr Jennifer Archer

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Dedication

This thesis is dedicated to My wife Dr Leandra Griffith Jean-Baptiste who, through her love, patience, support and understanding gave me the motivation needed to complete this degree.

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Abstract

There is a global decline in the number of students choosing science courses and pursuing science related careers. This problem is due in part to students' declining interest in science. This research study focused on preservice teachers' perceptions of how to enhance students' interest in science. The aims of this study were as follows:

1. How do primary and secondary (science) preservice teachers believe they can enhance students' long-term interest in science?
2. What are primary and secondary (science) preservice teachers' ideas for how to enhance students' long-term interest in science?
3. From where did primary and secondary (science) preservice teachers obtain their ideas for how to enhance students' long-term interest in science?

The researcher used a mixed methods research (MMR) design. This design was desirable because triangulation of the qualitative and quantitative aspects of the study helped to establish the validity and reliability of the study. The participants were 276 preservice primary and preservice secondary (science) teachers. There were 123 2nd year preservice primary and 112 3rd year preservice primary teachers who were enrolled in the Bachelor of Teaching (Honours) Primary program. In addition, there were 23 3rd year preservice secondary (science) teachers who were enrolled in the Bachelor of Teaching (Honours) Science Secondary program and nine 2nd year preservice secondary (science) teachers who were enrolled in the Secondary Science Masters of Teaching program.

Data were gathered using a quantitative survey, a qualitative questionnaire, interviews, and classroom observations. The quantitative data were analysed using the Statistical Package for

the Social Sciences (SPSS) software. The qualitative results were analysed using standard qualitative research techniques.

For Aim 1 (How do primary and secondary science preservice teachers believe they can enhance students' long-term interest in science?), it emerged that both primary and secondary (science) preservice teachers believed that they could enhance students' long-term interest in science. The 2nd year primary preservice teachers were the most confident in their ability to enhance interest in science.

For Aim 2 (What are primary and secondary science preservice teachers' ideas for how to enhance students' long-term interest in science?), both primary and secondary groups referred to the use of hands-on activities, making science relevant, using information communication technology (ICT), making science fun, making science student-centred, relating science to students' interests, and keeping students engaged.

For Aim 3 (From where primary and secondary science preservice teachers obtained their ideas for how to enhance students' long-term interest in science?), it emerged that both primary and secondary groups obtained their ideas from several sources including their university studies, practicum teaching, personal experiences, ICT/media, and their prior schooling.

In summary, the study revealed that preservice primary and preservice secondary (science) teachers were confident about their ability to enhance students' long-term interest in science. Even though many of their ideas would be supported by researchers studying the development of interest, there was no evidence that their ideas were based on a theoretical framework. Their ideas appeared to be intuitive ideas gained from their personal experiences.

Chapter One

Introduction

The New South Wales (NSW) science curriculum prescribes that teachers in both primary and secondary schools are expected to teach so that their students develop an interest in science. Yet it is not known whether preservice primary and secondary science teachers have ideas about how to do this. This study focuses on investigating pre-service teachers' perceptions of how to develop students' long-term interest in science.

1.1 Background

Students' perceptions toward science learning have been a subject of much concern in the scientific community. Many countries are now seeing record numbers of students, at university level as well as high school, not opting to pursue the sciences, and many of those who chose to do sciences at those levels are dropping them for other subjects**.** Danaia, Fitzgerald, and McKinnon (2013) reported, "Over the last two decades, in a number of developed countries, there has been a growing concern about both the waning interest many high school students display towards science at school and the declining number of students pursuing science in the post-compulsory years of secondary education" (p.1502). Ross, Whittington and Huynh (2017) asserted that globally there is a decline in the numbers of students graduating from Science Technology Engineering and Mathematics (STEM) courses and in Australia, despite the research and productivity drive geared at motivating students to take up STEM disciplines, over the past decade, there has been little growth.

In this section, the problem of declining student interest in science will be appraised with reference to the literature. The section will firstly examine studies that have been carried out in Australia in relation to students' declining interest in science. The second section will describe some age-related patterns. Finally, the extent to which this issue is represented in curriculum requirements will be exemplified.

1.2 Australian Studies About Student Interest in Science.

Over the last two to three decades a number of authors have noted the problem of decreasing enrolments in post-compulsory science, and declining interest in science has been regarded as one of the main causes of this trend. Dobson (2006) provided an historical perspective as it pertained to growth rate in science over the four-year period of 1999 to 2002 in Australia, the number of students enrolling into sciences by 2002 was well below the number of students enrolling in the non-science subjects. This was due to the fact that there was a new academic focus by the students on other disciplines such as behavioural sciences and biological sciences as well as on non-science disciplines instead of the enabling sciences of Chemistry Physics and Mathematics. Masters (2006, cited in Tytler, 2007) provided the following worrying statistics about the declining state of science education in the post-compulsory education in Australia:

- A decrease from 1978 to 2002 in the Year 12 Biology cohort from 55% to just over 20%, in the chemistry cohort from 30% to 15 % and in physics from 27% to 12%;
- The number of university students studying physical and materials science fell by more than 31% between 1989 and 2002;
- The proportion of Australian PhDs in Science and engineering dropped from 46.9% to 37.2% between 1989 and 2002;

- In 2001, only 1% of tertiary graduates in Australia were in the physical sciences, compared to 5.2% in the UK, and OECD mean of 2.6%. (p.13)

Declining interest in science has been proposed to be one of the main causes of this problem. Tytler (2007) stated that 61 per cent of year 12 students who do not chose science stated that their reason was because they did not like it or they found science to be boring. Similarly, Masters (2006, cited in Tytler, 2007) stated that secondary school students view science as uninteresting, irrelevant to their lives, and difficult to learn. Additionally, Lyon and Quinn (2010) stated that in Australia, approximately 55 percent of the students who did not chose science in their year 11 was because they did not regard their formative junior high school science as being interesting to them.

This problem is important because of its impact on society. Mack and Wilson (2014) argued that the downward trend in science participation by high school students meant that prospective science teachers are also on the decline. Lyons and Quinn (2010) argued that it would reduce the scientific literacy of the population and the numbers of science specialists available to help solve science-related issues in society. Lyons and Quinn (2010) continually asserted that in Australia over the past coupe decades, there have been a major decline in the numbers of high school students choosing senior science courses. This decline has been worrying since it would mean that the levels and quality of scientific literacy of Australian citizens would be on the decline as well.

1.3 International Studies of Decreasing Student Interest in Science.

The problem of declining student interest in science is of international concern. Croxford (2002) stated that despite the fact that science and technology is vital in today's global economy, young people especially are not opting for science subjects at school. Croxford (2002) continued to assert that in order to increase future science professionals, it is important to increase the science interest of young people. Similarly, Osborne, Simmons, and Collins, (2003) argued that youth have developed negative attitudes toward science, which has served as a contributing factor for the current decline in science globally. These authors argued that attitudes towards science would include “the feelings, beliefs and values held about an object which may be the enterprise of science, school science, the impact of science on society or scientists themselves” (p. 6). In this way, having an interest in science can be considered a type of attitude towards science.

1.4 Age Related Patterns.

A number of studies have indicated that declining interest in science does not apply equally across all ages. Research by Kahle and Lakes (1983) provided evidence that most students coming from the primary school have positive attitudes towards science, however this positivity lessons significantly as the students participate in science subjects in the secondary schools.

Osborne et al. (2003) presented data based on a measurement of attitudes by the TIMMS survey in 1996 which showed that “the decline in interest may not be linear but accelerate rapidly from 14 onwards” (p.13). Osborne et al., (2003) stated that research studies have shown that from the time children enter secondary schools, their interest in and attitude for science declines and this declining interest in science may have even started from the primary schools as research in UK schools may have suggested.

Thus, the literature has indicated that there may be some declines in interest in science during the primary years, but the most marked declines occur during the primary-secondary transition and the early years in secondary school.

1.5 Interest as a Requirement of the School Science Curriculum

The previous sections have shown that declining interest in science may occur at primary school and secondary school. In this section, some primary and secondary school science syllabi will be analyzed to identify any statements about the importance of enhancing student interest, and the implications this may have for teachers. Most attention will be on the syllabi that are most relevant to students in the state of New South Wales, since this is where the study was located. However, the Australian national syllabus, and some selected international syllabi will be included for comparison.

1.5.1 The New South Wales Science Syllabus

In the NSW primary syllabus (Board of Studies, 2013) one of the Aims is to:

> Foster students' sense of wonder and expand their natural curiosity about the world around them in order to develop their understanding of, *interest* [emphasis added] in, and enthusiasm for science and technology (p.14).

Additionally, one outcome is that a student "shows *interest in* [emphasis added] and enthusiasm for science and technology, responding to their curiosity, questions and perceived needs, wants and opportunities" (p.16).

In the NSW secondary science syllabus (Board of Studies, 2013) one of the Aims is that the syllabus seeks to develop students' "*interest* in and enthusiasm for science, as well as an appreciation of its role in finding solutions to contemporary science related problems and issues" (p. 79).

Thus, the NSW primary and secondary syllabi both explicitly state that developing student interest in science is one of the central aims. This implies that teachers would be expected to have an understanding of how to achieve this aim.

In short, the syllabus examined here show considerable variation in the extent to which the enhancing of student interest in science is explicitly stated. It is noted that the NSW syllabus explicitly presented the development of student interest in science as a main aim, which implies that teachers would need to have knowledge of how to achieve that aim.

1.6 Summary

In this chapter, it has been argued that, due to the declining interest in science among students, and its potential effects on post-compulsory science enrolments and scientific literacy generally, there is a need to enhance student interest in science. This is apparent from Australian science syllabus documents, in which it is stated as one of the main aims of science education. This implies that teachers will need to be armed with effective means of ensuring that their students do enhance interest in science.

Chapter Two

Literature Review

This chapter provides an outline of the theoretical underpinnings of the study. The chapter will begin by examining the construct of "Interest", in section 2.1. Section 2.2 presents information on how to develop individual interest from situational interest. Pre-service teachers' interest in science is presented in section 2.3. In addition, the chapter will include a section on self-efficacy (section 2.4), because preservice teacher self-efficacy for enhancing student interest will be one aspect of the study. The final section of this chapter gives a summary of the literature reviewed and the aims of the research are presented in light of the literature.

2.1 Interest

Krapp, Hidi, and Renninger (1992) defined interest as the inter-relation that exists between students and their environment. It has been generally agreed that interest has both cognitive and affective components. Dohn (2013) for example, indicated that interest is a positive mental and affective experience which can serve to direct and focus an individual's attention to a particular task or activity. Schraw and Lehman (2001) focused on positive affect, as they stated that interest-based activities are characterized by a show of happiness, pleasure, and well-being. Schraw and Lehman (2001) argued that this led to the focusing of attention as well as engagement.

Hidi and Renninger (2006) argued that the concept interest is not only a state but a disposition of an individual. They used the term *situational interest* to refer to the state of interest, and the term *individual interest* to refer to the ongoing predisposition, as follows.

2.2 Situational Interest

Krapp et al. (1992) stated that situational interest is activated by the environment and is spontaneous as well as being transitory in nature. Similarly, Dohn (2011) defined situational interest as "certain conditions and/or stimuli in the environment that focus attention and that cause an immediate affective reaction that may or may not last over time" (p. 339).

Situational interest is important because of its potential to motivate students, even those who are not necessarily predisposed towards the content. Hidi and Harachiewicz (2000) argued that a focus on situational interest will help educators to encourage and motivate students to be involved in specific content areas "foster students' involvements in specific content areas and increase their levels of academic motivation" (p.153). Schraw and Lehman (2001) stated that situational interest would enhance attention and learning.

2.2.1 Causes of Situational Interest

Jack and Lin (2014) provided a comprehensive review of the sources of situational interest that have been shown to be important in science education. They concluded that novelty, meaningfulness, and involvement are the three most critical causes of situational interest. Jack and Lin (2014) stated "When these three elements are combined, their reaction can produce a significant shift in attitude from a negative interest to a positive interest among students in the science classroom" (p. 802). Jack and Lin (2014) defined **novelty** as "any perspective or approach that is perceived as new and different from that experienced as part of a student's everyday life" (p. 800). Moreover, they stated that when activities are unexpected or suprising, different from the normal classroom experience and new, students' situational interests becomes triggered. Dohn (2011) similarly argued that novelty is the difference between known and unknown information, which can be a motivating factor, encouraging a person to develop exploratory behaviour. Furthermore, Jack and Lin (2014) asserted that novelty could be influenced by other factors such as a student's personal interests and social/ historical processes during learning.

Jack and Lin (2014) stated that **meaningfulness** occurs when the material to be learnt is seen as personally relevant to the student. For an event to be relevant to a student, that event would have to be able to connect past information to present information from the learning activity. Also, Jack and Lin (2014) argued that when students are able to connect their past information with their current knowledge, they are able to become more curious and motivated toward future learning. Jack and Lin (2014) exemplified the concept of meaningfulness by drawing reference to a situation where parents demonstrating a keen interest toward science, technology, engineering, and mathematics (STEM) and thereby providing students with a strong enough reason for developing positive interest towards a science learning task and consequently engaging in that task.

Jack and Lin (2014) proposed that students experience **involvement** in an educational activity when they are either physically or mentally participating in that activity. They argued that, when students are involved in their learning socially and mentally, they tend to learn more. Personal activities, such as hands on experiences, and social activities such as group work helps students feel a deep sense of autonomy as well as acceptance and connected to other students whom they consider to be important (Jack & Lin, 2014). This ultimately can lead to a student developing a mind-set and mood of excitement as well as fun, which this student ultimately can use as a base for learning from and helping their peers. Furthermore, Jack and Lin (2014) stated a students' situational interest in a science learning activity is maintained by being involved in fun activities as well as relating it to significant others. Hidi and Harachiewicz (2000) asserted that involvement could be influenced by the type of people with which one worked. For example, they stated that students of the same sex (girls), were more inclined to show greater levels of interest in physics classes when they were taught in an all-girls class.

Some other sources of situational interest have been proposed in addition to novelty, meaningfulness and involvement. Hidi and Harachiewicz (2000) claimed that students' interest levels are enhanced when they are given choices in the classroom, because students feel a sense of autonomy and self-determination in order to achieve the academic task. Schraw and Lehman (2001) studied text-based situational interest and stated that "it was elicited by a variety of factors such as prior knowledge, unexpected text content, text structure, and reader goals" (p.27). Other possible sources of situational interest in science have included knowledge acquisition, personal anecdotes, and using a variety of information sources (Dohn, 2011; Jack & Lin, 2014).

2.3 Individual Interest

Hidi and Harackiewicz (2000) defined individual interest as,

> a relatively stable motivational orientation or personal disposition that develops over time in relation to a particular topic or domain and is associated with increased knowledge, value, and positive feelings (p. 152).

Schiefele, (1992) asserted that this type of interest is long lasting and robust. Other researchers have also often "directed toward some specific activity or topic (e.g., interest in sports, science, music, dance, or computers)" (Schunk, Meece, & Pintrich 2014, p. 214).

Individual interest is important. Schunk et.al. (2014) stated that "much of the vocational education and career choice literature is based on assessing individuals' interests in different activities and careers" (p. 214). Individual interest is educationally important because it has powerful effects on learning. Ainley, Hidi, and Berndorff (2002) stated that individual interest is associated with positive affect and persistence, so it tends to result in increased learning: "the reader with an individual interest in ecology and conservation seeks opportunities to engage in associated activities and while so engaged experiences enjoyment and expands his or her knowledge" (p. 545).

2.4 Developing Long-Term Interest (How Individual Interest Develops)

Hidi (1990) asserted that over time, situational interest may develop ultimately into individual interest. Dohn (2011) similarly stated that sometimes if students' situational interest become triggered frequently, they may develop individual interest overtime.

Hidi and Renninger (2006) developed a four-phase model that showed how regular experiences of situational interest in a subject area can eventually develop into individual interest. The model adds on to previous research in the field of learning and interest, and each stage in the model is viewed as sequential and separate. The model therefore serves to highlight the way interest can be developed in persons, as well as creative methods via which educators can develop interest for their specific content areas.

Phase One of the four-phase model is *Triggered Situational Interest*. Hidi and Renninger (2006) stated this is a psychological state of interest, which can result in short term changes in affective and cognitive processing. Some of the ways in which triggered situational interest can be generated include via features in the environment, surprising information and personal relevance.

The second phase is *Maintained Situational Interest*, which, "involves focused attention and persistence over an extended episode in time, and / or reoccurs and again persists" (p.115). Hidi and Renninger (2006) explained that this phase is mainly externally supported as students' interest is sustained through active involvement in games, group work, and one-on-one interaction with other peers. The third phase is *Emerging Individual Interest*, in which the student will opt to reengage in a task over time if given the opportunity. Hidi and Renninger (2006) stated that this type of interest is self-generated but also "requires some external support, in the form of models or others such as peers, experts and so on" (p.115). This phase is "characterized by positive feelings, stored knowledge and stored values" (p. 114). Hidi and Renninger (2006) argued that the student begins to generate "curiosity" questions, and is likely to be resourceful in seeking answers to questions. Thus, the student will be better at tasks and go beyond tasks request in their schooling activities. The fourth phase is *Well-Developed Individual Interest*. Hidi and Renninger (2006) stated that when a student has a well-developed individual interest, he or she has positive feelings and has more stored knowledge and value for a specific content. Although this phase is primarily self-generated, the student will still benefit from external support. Students who have well-developed individual interest will engage in long-term constructive and creative endeavours that can result in them developing model ways of solving and working with tasks. Hidi and Renninger (2006) also maintained that a learner with well-developed individual interest will persevere with work, even in the face of frustration.

Some modifications have been proposed to Hidi and Renninger's (2006) model. Linnenbrink-Garcia et al. (2010) for example, proposed that maintained situational interest can be further divided into maintained-feeling and maintained-value. Maintained-feeling was regarded as affective, as students experience "positive affect towards the domain via instructional support" (p. 593). The maintained-value form was regarded as cognitive, as students are involved in "finding meaning and personal usefulness in the domain via instructional support" (p. 593).

However, there has been an important omission from this research on the development of long-term interest. At this time, none of the previous studies have investigated teachers' ideas about how to enhance students' long-term interest in science. Thus, the extent to which teachers' ideas might agree or disagree with those of Hidi and Renninger (2006) is not known.

2.5 Preservice Teachers' Interest in Science

The participants in this project were preservice teachers, so the purpose of this section is to provide an overview of what the research tells us about their interest in science. It has been found that many preservice *primary* teachers do not hold favourable attitudes towards science (Riegle-Crumb Morton, Chimonidou, Labrake, & Kopp, 2015) largely due to negative experiences of science at high school (Jarrett, 1999). Palmer (2004) stated that science research has shown that science subject, especially physical sciences, are generally disliked by primary teachers and primary education students and that both those groups of persons seem to have a limited grasp of science knowledge.

This is a problem, because when teachers have limited knowledge of science and dislike science, they are not likely to spend much time teaching the subject (Goodrum, Hackling, & Rennie, 2001). Thus, the identification of practices to improve the science attitudes and interest of primary teacher education students has been a strong focus of recent research.

On the other hand, preservice *secondary* science teachers generally have positive attitudes towards science and teaching science. Ates and Saylan (2015) reported highly positive academic motivation towards biology among secondary biology teachers. Hong and Greene (2011) found that secondary science teachers' altitudes towards science were mainly based on their past experiences of learning science. Furthermore, Talanaquer, Novodvorsky, and Tomanek (2010) reported that secondary science teachers had a strong interest in the potential of instructional activities to motivate. Akbulut and Karakuş (2011) reported positive attitudes towards the profession of science teaching among this group. It has also been found that self-efficacy to enhance students' interest can vary between different types of preservice teachers.

2.6 Self-Efficacy

Self-efficacy was defined by Bandura (1981) as "Judgements about how well one can organize and execute courses of action required to deal with prospective situations that contain many ambiguous, unpredictable and often stressful elements" (p.200). Thus, self-efficacy represents one's belief about one's ability to perform a challenging task. Self-efficacy is important because of its ability to predict behaviour. People who have a high self-efficacy for a certain task will be more willing to attempt that task and will tend to persist with it when difficulties are encountered. Whereas individuals with low self-efficacy for that task will be more likely to avoid the task or give up when difficulties occur. Bandura (1997) stated that "different people with similar skills or the same person under different circumstances may perform poorly, adequately, or extraordinarily depending on fluctuations in their beliefs of personal efficacy" (p.37). An important characteristic of self-efficacy is that it is specific to a particular task, and in this way, it differs from constructs such as self-concept, self-worth, and self-esteem, which have more global connotations (Tschannen-Moran, Woolfolk-Hoy, & Hoy, 1998).

Bandura (1997) stated that there are four sources of efficacy information, namely enactive mastery experiences, vicarious experiences, verbal persuasion, and physiological/affective states. Enactive mastery experiences are occasions on which one performs the task successfully. Bandura (1997) argued that these occasions provide the most powerful source of efficacy information because they are authentic evidence of one's ability to succeed in the task. Vicarious experiences occur when individuals observe other persons who are successfully performing the task, which leads the observer to also believe that the task is within his/her capabilities. Bandura (1997) argued that this builds efficacy beliefs "through transmission of competencies and comparison with the attainments of others" (p.79). Verbal persuasion occurs "when one receives feedback and encouragement from other people, indicating that one has the capability to perform the task" (Palmer, 2011, p.580). Verbal persuasion is likely to be particularly effective when it is received from a person who is perceived as highly competent in the field. One's physiological and affective states can also influence self-efficacy judgements: Bandura (1997) stated that most people, when placing judgement on their capabilities to do something, "rely partly on somatic information conveyed by physiological and emotional states" (p.106). Thus, acute levels of stress and fear in relation to a task can lower one's self-efficacy for performance of that task

2.6.1 Teacher Self-Efficacy

Teaching can be a challenging task, and **teacher self-efficacy** has been defined as the "extent to which a teacher believes he or she has the capacity to affect student performance" (Tschannen-Moran et al., 1998, p. 202). Teacher self-efficacy is important because it determines how teachers will approach the task of teaching. Bandura (1997) argued that instructors with high teacher efficacy believe that if they add the extra effort and use the right pedagogical techniques, they can actually teach difficult students. Bandura (1997) also believed that if a teacher had a low self-efficacy he/she would believe that there is nothing they could do to assist an unmotivated student.

According to Bandura (1997) teachers with a high sense of instructional efficacy do a better job of preparing lesson plans, managing classroom discussions and other instructional activities, they tend to use persuasion rather than authoritarian control, and will support the development of their students' intrinsic interest and academic self-directedness. This in turn has positive effects on student learning and achievement. On the other hand, teachers with low instructional efficacy have a weaker commitment to teaching and spend less time on subject matter that may be challenging for students. For these reasons Tschannen-Moran and Woolfolk Hoy (2007) stated that self-efficacy is "a self-fulfilling prophesy" (p. 945). However, a teacher's instructional efficacy can vary from subject to subject, so a teacher who is highly efficacious in language may be less efficacious in science, or vice versa (Bandura, 1997).

2.6.2 Science Teaching Self-Efficacy

The low science teaching self-efficacy of primary teachers has been a concern to educationalists for many years. Skamp (1991) found that both preservice and in-service primary teachers had low confidence (note that the term "confidence" has often been used interchangeably with self-efficacy) for teaching science. The terms confidence and self-efficacy do not technically mean the same thing, they are slightly different in some ways. For instance, Bandura (1997) indicated that self- efficacy the belief that a person can do a particular task very well, for example one can say they have a high self-efficacy to play the sport cricket.

This is different from confidence since confidence can be viewed as overarching theme with respect to a group of activities, for example one can have a high confidence for playing sport however this individual can have a low efficacy for play a particular sport such as basketball. Despite this difference, in the past the terms confidence and self-efficacy have been used interchangeably.

More recent studies have tended to confirm this pattern (Sandholtz & Ringstaff, 2011). Low self-efficacy for science teaching is a critical issue because of its effect on teaching quality and student learning. Harlen and Holroyd (1997) reported that in UK primary schools, teachers with low confidence tended to have a poor understanding of science concepts, and this severely limited the children's learning. Similarly, Appleton and Kindt (1999) reported that the poor quality of science teaching that occurred in many Australian primary schools was partly due to low levels of teacher confidence (self-efficacy). Andersen, Dragsted, Evans, and Sørensen (2004) reported that the quality of science teaching in Danish elementary schools correlated with the teachers' self-efficacy scores. It has been found however, that science teacher efficacy can be positively influenced by appropriate interventions. Bleicher and Lindgren (2005) for example, reported positive gains in science teaching self-efficacy among preservice primary teachers in a constructivist-oriented methods course. Similarly, Palmer (2011) found that the science teaching self-efficacy of practicing primary teachers was enhanced by an intervention that included mastery experiences, modelling, and verbal persuasion.

It should be noted that this pattern of low, science teaching self-efficacy among primary teachers does not necessarily apply to secondary science teachers. Savran and Çakiroglu (2003) compared elementary and secondary science preservice teachers and found that the secondary preservice teachers were more efficacious than their elementary counterparts. Haigh and Anthony (2012) however, warned that secondary science teachers may feel more efficacious in some science topic areas compared to other science topic areas

2.6.3 Specificity of Science Teaching Self-Efficacy Beliefs

In many studies, science teaching self-efficacy has been measured as a global construct, and these studies have tended to use broadly focused instruments such as the Science Teaching Efficacy Belief Instrument (STEBI versions A and B) developed by Enochs and Riggs (1990). In recent years however, it has been recognised that teachers may hold different levels of efficacy about different aspects of science teaching. For example, studies have focused on efficacy for teaching science by inquiry (Seraphin, Philippoff, Parisky, Degnan, & Warren, 2013), integrating Facebook into chemistry teaching (Blonder & Rap, 2017), teaching socioscientific issues (Kilinç et al., 2014), and integrating ICT into science (Annetta, Frazier, Folta, Holmes, Lamb, & Cheng, 2013).

However, there is an important omission from this research on science teaching efficacy. At this time there appears to have been no study that has investigated teacher efficacy beliefs about their ability to enhance students' long-term interest in science. This is one focus of the present study.

2.7 Summary and Aims of the Research

The literature cited in this chapter has revealed that students' long-term interest (individual interest) can be enhanced by providing experiences of situational interest. However, it is not known whether preservice teachers have ideas about how to enhance students' long-term interest in science, nor the extent to which these might be in accord with the literature. This is an important issue, because it is today's preservice teachers who will be faced with the task of building an interest in science among their future students. Indeed, as stated in Chapter One, the development of student interest in science is one of the aims of the relevant primary and secondary science syllabi for these preservice teachers.

It should be noted however, that simply having ideas about how to enhance student interest in science does not necessarily mean that preservice teachers will act upon those ideas when they become teachers. As noted in this chapter however, self-efficacy beliefs can provide a powerful predictor of teacher actions in the classroom. Therefore, if preservice teachers believe they can enhance student interest in science then they will be more likely to implement the actions that are necessary to make that happen. Consequently, the aims of this study were,

1. How do primary and secondary (science) preservice teachers believe they can enhance students' long-term interest in science?
2. What are primary and secondary (science) preservice teachers' ideas for how to enhance students' long-term interest in science?
3. From where did primary and secondary (science) preservice teachers obtain their ideas for how to enhance students' long-term interest in science?

Chapter Three

Research Methodology

This chapter provides an outline of the planning and execution of the data collection phase as well as the data analysis procedures. In section 3.1 this chapter will start by stating the research design, and will then give a brief overview of the University of Newcastle teacher education programs (Section 3.2). The chapter will then describe the participants (Section 3.3). The Data collection and analysis procedures will be described in Section 3.4.

3.1 Research Design

This study involved a combination of qualitative and quantitative procedures and as such the research employed a mixed method research (MMR) design. Punch and Oancea (2014) defined MMR as “empirical research, which involves the collection and analysis of both qualitative and quantitative data” (p. 338). They also indicated that mixed methods research allowed more about a particular research topic to be known since,

> We can combine the strengths of methods focused on quantitative data with the strengths of methods focused on qualitative data while compensating at the same time for the weaknesses in each method (p. 339).

This particular research design therefore was appropriate because triangulation of the qualitative and quantitative aspects of the study will establish validity and reliability. Thus, data for this study were collected by survey, questionnaire, interviews, and classroom observations.

MMR, despite being a very good methodology, is not without its weaknesses. For instance, Johnson and Christensen (2012), argued that the findings from MMR may not be generalizable. In this research, the researcher focused only on students at the University of Newcastle and as such the research may not generalizable to other universities. This limitation should be considered when interpreting the findings.

3.2 Overview of University of Newcastle Teacher Education

The main campus of the University of Newcastle (UON) is located in the Hunter region of New South Wales (NSW) with other campuses located at the Central Coast and Mid-North Coast regions of NSW. The University of Newcastle is the largest teacher education provider in the region. The University of Newcastle, School of Education website states that it aims to produce inspiring teachers, insightful scholars and innovative education leaders. The University of Newcastle provides the following teaching degrees:

1. Bachelor of Teaching (Primary) (Honours)
2. Bachelor of Teaching (Early Childhood and Primary) (Honours)
3. Bachelor of Teaching (Health and Physical Education) (Honours)
4. Bachelor of Teaching (Humanities) (Honours)
5. Bachelor of Teaching (Mathematics) (Honours)
6. Bachelor of Teaching (Secondary)
7. Bachelor of Teaching (Primary)
8. Bachelor of Teaching (Secondary Science) (Honours)

9. Master of Teaching (Primary)
10. Master of Teaching (Secondary)

The University of Newcastle Initial Teacher Education programs follow the Quality Teaching Model which according to the Department of Education and Training (2003) comprises of three main dimensions of pedagogy namely,

1. Intellectual Quality
2. Quality learning environment
3. Significance

This model aims to create a foundation for providing quality teacher training which ensures that graduates gain teacher qualifications aligned with the NSW Department of Education requirements.

In summary, the University of Newcastle has a rich culture of teacher education and a wide variety of teacher education programs. It was therefore an appropriate setting for this research.

3.3 Participants

Preservice teachers from the Bachelor of Teaching (Primary) (Honours), the Bachelor of Teaching (Secondary Science) (Honours) and the Master of Teaching (secondary science) programs from the University of Newcastle (Callaghan and Central Coast campuses) were selected as the sample for this study. These two campuses were chosen because they had the largest numbers of preservice teachers. These students were appropriate for study because they will, in future years, be required to implement the aims of the science syllabus, including the development of their students' interest in science. It was therefore important to find out whether and /or how the teachers intend to develop their students' interest in science.

An additional criterion for selection was that the participants should have completed (or at least be enrolled in) their science methods courses. The reason for this was that the science methods courses would perhaps be where students might have learnt how to teach science in a way that would maximise student interest. Thus, only students from the second and third year of their teacher education program were included in this study. Four groups of participants were involved; 2nd year primary undergraduates, 3rd year primary undergraduates, 3rd year secondary science undergraduates, and 2nd year secondary science postgraduates (from the Master's program). All students attended the University of Newcastle.

The total numbers of students and their gender in this study can be seen in Table 3.1.

Table 3.1

Total Numbers of Participants

Program	**Year**	**Sample**	**Gender**		
			Male	**Female**	**Not Stated**
Bachelor of Teaching (primary)	2	123	25	95	
Bachelor of Teaching (primary)	3	112	27	81	4
Bachelor of Teaching (Secondary Science)	3	23	14	9	
Masters of Teaching (Secondary Science)	2	9	3	6	
TOTAL		267	69	191	4

3.3.1 Recruitment Methods

Different recruitment techniques were used for different methods of data collection. Participants for the **survey and questionnaire** were sought during science methods lectures and tutorials. The researcher, with the lecturers' permission, at the end of the lecture, informed students about the study and requested their participation in a survey. An information sheet (Appendix A) was provided along with the survey. The participants were asked to place their completed (or uncompleted) survey in a collection box located in the classroom. Students were given as much time as they needed to complete the survey (usually about fifteen minutes).

For participation in the **interviews**, students were provided with a consent form (Appendix B) for interviewing which they were required to fill in after the survey, if they wanted to participate in an interview. Students who were willing to be interviewed were asked to write their contact email on this form, so they could be contacted at a later time by the researcher to arrange a time for the interview.

With regards to the **classroom observations**, the researcher obtained permission from the primary and secondary science methods lecturers. The researcher gave the lecturers a copy of the information statement and the lecturers were asked to state whether they were willing to be part of their study by having one of their classes observed.

3.3.2 Ethical Considerations

Ethics are an integral part of any study. Cohen, Manion, and Morrison (2011) indicated 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). One of the main ethical considerations was that participants were not to be harmed, or coerced and that their confidentiality should be maintained (Gay, Mills, & Airasian, 2009). As such, this section describes the ethical practices were undertaken during the study.

The researcher applied for ethical approval for the study in April 2016 and obtained ethical approval in June 2016 (Protocol Number H-2016-0169). The participants were given a package which contained the information statement that outlined the purpose of the study, research methodology, and timeframe of collecting data. Additionally, the package contained advice that participants' names would not be used in any publication of the study.

Recruitment by implied consent was used in this research. Howe and Moses (1999) indicated that informed consent in research is pivotal because it respects a person's basic human right to make their own decisions and to have freedom of action. The researcher used implied consent in relation to the survey, as completion of the survey implied their consent. Similarly, if students provided their contact details on the consent form for interview, it was taken as implied consent for participation in the interview.

3.4 Data Collection and Analysis

In this study, the researcher used a combination of quantitative and qualitative methods. The quantitative component involved the survey and classroom observations, whilst qualitative data came from the open-ended questionnaire and interviews. Table 3.2 shows the aims of the study and the data collection method used to acquire information about that aim during the study.

Table 3.2

Research Aims and Data Collection Method

Aim	*Data Collection Method*
How do primary and secondary (science) preservice teachers believe they can enhance students' long-term interest in science?	Survey, Interviews
What are primary and secondary (science) preservice teachers' ideas for how to enhance students' long-term interest in science?	Survey Interviews
From where did primary and secondary (science) preservice teachers obtain their ideas for how to enhance students' long-term interest in science?	Classroom Observations, Survey, Interviews.

3.4.1 Survey

The main purpose of the survey was to obtain data about participants' self-efficacy that they would be able to enhance students' long-term interest in science. The survey was developed specifically for this study since the researcher could not find any existing survey on teacher self-efficacy for enhancing students' long-term interest in science. The items for the survey were loosely based on the self-efficacy scale that was developed by Enochs and Riggs (1990).

The survey items were trialled by pilot testing with three students who were not included in the study. The completed survey can be seen in Appendix C.

The survey consisted of 12 items linked to a four point Likert scale (Strongly Agree, Agree, Disagree, Strongly Disagree). Some items were positively worded and others negatively worded, in order to minimize repetitive answering. The 12 items are listed in Table 3.2.

Table 3.3

Survey Items for the Likert Scale

It is important for teachers to increase students' long-term interest in science.
I do not have the strategies to enhance students' general liking for science.
I know how to increase students' long-term interest in science.
It is not the teacher's responsibility to increase students' interest in science.
I have the skills to increase students' long-term interest in science.
My university program has not prepared me with strategies to increase students' long-term interest in science
I know how to motivate students' general interest in science.
If I had students who did not like science, I am sure I could get them to like science.
My university program has prepared me well to enthuse students about science.
I believe I can help students develop an enjoyment of science.
I am confident that my future students will learn to love science.
I am responsible for maximizing my students' long-term interest in science.

After the survey was administered to the participants, it was further refined by the researcher. A total of 290 surveys were distributed among the four groups of preservice teachers as noted in Table 3.4. In response, there were 267 participants who completed the survey. As such, the response rate was calculated as being 92.10%. Table 3.3 shows the response rate for the survey among the participants by their educational grouping at the university.

Table 3.4

Response Rate by the Four Student Groups

	Overall	2nd year Primary (U/G) *	3rd Year Primary (U/G)	3rd year Secondary Science (U/G)	2nd year Postgraduate (P/G) **
Survey Sent	290	120	120	30	20
Survey received	267	118	103	22	9
Total %	92.10%	98.33%	85.83%	73.83%	45.00%

1. ***U/G=Undergraduate Program**
2. ****P/G=Postgraduate Program**

To analyse the survey, the responses were coded using a scale of 1 to 4. A score of 4 represented a high level of efficacy (confidence) that preservice teachers can increase their students' long-term interest in science, and a score of 1 represented a low level of confidence that preservice teachers can increase their students' long-term interest in science. The negatively worded items in the Likert scale were reverse coded also to ensure that all items were on equal weighting. Students' scores were entered into the Statistical Package for the Social Science (SPSS) software for quantitative analysis. The details of this analysis and refinement of the survey are described in the next chapter.

3.4.2 Open-ended Questionnaire

The survey described above was accompanied by a questionnaire section containing open-ended questions. The purpose of this questionnaire was to allow the preservice teachers to explicitly state their opinions about how to increase student interest in science as well as to explain from where they had obtained their ideas. These questions were,

1. Please list three classroom techniques you could use to increase students' long-term interest in science.
2. For students to develop a long-term interest in science, how often should they experience those classroom techniques?
3. From where did you acquire your ideas about how to increase students' long-term interest in science?

Standard qualitative techniques were used to code responses to each open-ended question. This involved the initial coding of response segments that seemed to express the same idea. The responses to the open-ended questions were initially coded with low inference descriptors using the verbatim language used by the participants. These categories were then combined into broader categories if they seemed to express the same idea. The percentages of students in each category was calculated to identify the most important categories. To estimate inter-rater reliability, a sample of 45 response segments were independently coded by the researcher and a colleague and agreement was found in 91% of instances.

3.4.3 Interviews

Oancea and Punch (2014) argued that the primary purpose of an interview is to explore the perceptions, and system of meanings of an individual as well as definitions of a situation and constructions of reality. They further asserted that interviews are “one of the most powerful ways we have of understanding others” (p.182).

The main purpose of the interviews was to provide additional information about preservice teachers’ self-efficacy beliefs about their ability to increase their children’s long-term interest in science, as well as their ideas about how to achieve it and the sources of those ideas. The researcher used the guided-interview approach. Cohen, et al. (2011) asserted that in this type of interview, “topics and issues to be covered are specified in advance, in an outline form; interviewer decides sequence and working of questions in the course of the interview” (p. 413). The main reasons why the researcher chose this type of interview were:

> The outline increases this comprehensiveness of the data and makes data collection somewhat systematic for each respondent. Logical gaps in data can be anticipated and closed. Interviews remain fairly conversational and situational (Cohen et. al., 2011, p. 413).

The interview questions (see appendix D) were developed using a series of 3 pilot interviews with three preservice teachers. The interview guide questions were,

1. Do you feel confident that you could increase your students’ long-term interest in science when you become a teacher?

2. On a scale of 1-10 with 10 being the highest how confident are you that you can increase your students' long-term interest in science when you become a teacher? (Please explain)
3. How would you improve your students' long-term interest in science?

   Is there anything else you would do? (Can you explain each one?)
4. From where did you get your ideas for how to increase your student's long-term interest in science?

Thirteen students were interviewed: 8 preservice primary teachers and 5 preservice secondary science teachers. In the primary group, there were 6 females and 2 males. In the secondary group, there were 2 postgraduate (Masters) students (male and female) and 3 third year undergraduates comprising two males and one female. Thus, the interviewees were fairly representative of the gender demographic of the study as a whole. As all of these students volunteered to be interviewed, it raised the question of whether these were students who were naturally more positively inclined towards science. This did not appear to be the case, because the interviews revealed that about half of the primary interviewees stated they had low interest/confidence for science (e.g., "I am still not very confident in science, so I am worried about how I am going to teach my children to love science when I don't love it myself" third year primary female). As expected, the secondary interviewees all expressed positive dispositions towards science (e.g., "I believe in science education, and I believe with that and some other skills that I've picked up along the way, and yeah I can foster students' long-term interest in science" (male secondary undergraduate). Thus, the interviewees can be assumed to be a reasonably representative sample of the participants.

Table 3.5

Participants of the Interview by Educational Grouping

Program	**Year**	**Gender**	
		Male	**Female**
Bachelor of Teaching (Primary)	2	0	2
Bachelor of Teaching (Primary)	3	2	4
Bachelor of Teaching (Secondary science)	3	2	1
Masters of Teaching (Secondary Science)	2	1	1
TOTAL		5	8

Each interview was recorded and transcribed verbatim. Standard qualitative techniques were used to analyse the interview transcripts. This involved the initial coding of the responses based on the literal wordings used by the students then combining of those into larger categories that seemed to express the same idea. The percentage of students in each category was calculated to identify the main categories of response.

3.4.4 Classroom Observations

Classroom observations can be used to provide data about instructional practices and student behaviours within natural and authentic settings. They have often been used to triangulate with other data, such as survey responses, to understand learner engagement (Weber, Waxman, Brown, & Kelly, 2016). In the present study, three observations were carried out: a primary science education lecture, a primary science education tutorial/workshop, and a secondary science education tutorial. The primary lecture session involved a large group of over 100 students, the content covered ideas for teaching the topic of “astronomy”, and was delivered by an instructor using explanation, diagrams, and demonstrations, but with relatively little interaction with the students. The workshop sessions involved smaller groups of roughly 20 primary preservice teachers and 10 secondary science preservice teachers respectively. These were more interactive than the lecture, including discussion, questioning, and small group work. The primary methods workshop focused on lesson sequencing for the topic of "magnetism". The secondary methods workshop was focused on lesson planning and sequencing.

The classroom observation checklist was developed as follows. The student questionnaire and interviews had suggested that activities from university science education courses had played an important role in developing students' ideas for how to enhance student interest. The purpose of the classroom observations was to provide additional evidence that interest-arousing events (i.e., situational interest) had occurred in those courses. It was therefore necessary for the observations to focus on sources of situational interest. Unfortunately, however, there appeared to be no existing classroom observation instrument for sources of situational interest, so it was necessary to develop one for this study.

The final version of the observation checklist (seen in Appendix E) included three sources of situational interest, namely novelty (unusual or surprising content), involvement (physical actions of doing activities, discussing, or group work), and relevance/meaningfulness (making explicit relevance to real life or the school context). These were selected on the basis that previous research had identified them as important sources of situational interest (Hidi & Renninger, 2006). The observer sat at the back of the room and tried to remain as inconspicuous as possible. A one minute observation was carried out every third minute for 30 minutes (i.e., during the middle part of the one hour session), and a tally was made of any novelty, involvement, or meaningfulness that occurred during that time. The observer also briefly noted what each of these events was, and made short notes about any student statements or behaviours that may have indicated their interest. Analysis of the checklist was carried out by summing the number of occasions on which novelty, involvement, and meaningfulness had been recorded in each teaching episode. In addition to using the observational checklist to note instances of novelty, relevance/meaningfulness, and involvement being observed in the lecture, the researcher also used anecdotal records and field notes to record some of what the students may have said and experienced throughout the observation period.

The observer trained for this task by carrying out two lesson observations that were not included here. To estimate reliability, the observer and a colleague independently carried out a full lesson observation using the tally sheet. The tallies were 93% in agreement.

Chapter Four

Quantitative Data Analysis

In this chapter, an analysis of the quantitative data is conducted. Section 4.1 describes the participants. Section 4.2 describes the survey. Section 4.3 presents the development of the scale used to assess preservice teachers' confidence that they can enhance students' interest in science. Section 4.4 and Section 4.5 presents analyses using this scale. It should be noted that although the classroom observations were essentially quantitative in nature, they are presented in the next chapter because they are more aligned to the qualitative data gathered for the present study.

4.1 Participants

The participants for the survey component of the study were undergraduate preservice 2nd year primary teachers, undergraduate preservice 3rd year primary teachers, undergraduate preservice 3rd year secondary science teachers, and postgraduate 2nd year secondary science teachers. All students attended the University of Newcastle.

A total of 290 surveys were distributed to the four groups noted above. In response, 267 completed the survey, a response rate of 92.10%. There were considerably more females (71.53%) than males (27.34%). Because of the sex imbalance, no analyses by sex were conducted. The majority of the responses came from the 2nd year preservice primary teachers (44.19%). Table 4.1 shows the response rate for the survey among the participants by their grouping at the university.

Table 4.1

Response Rate by the Four Student Groups

	Overall	2nd year Primary (u/g)	3rd year Primary (u/g)	3rd year Secondary Science	2nd year Master Science (p/g)
Survey Sent	290	120	120	30	20
Survey Received	267	118	103	22	9
Total %	92.10%.	98.33%	85.83%	73.33%	45.00%

4.2 The Survey

The survey items were presented in Chapter 3. The survey contained 12 items with a four point Likert scale ranging from Strongly Disagree (1) to Strongly Agree (4). Three out of the 12 questions were negatively worded. For the analyses, these items were reverse coded. Table 4.2 shows the items in the survey as well as their respective means and standard Deviations (SD) for all participants.

Table 4.2

Means and standard deviations for the survey items

Item	N	Mean	SD
It is important for teachers to increase students' long-term interest in science.	266	3.54	0.53
I do not have the strategies to enhance students' general liking for science. *	266	2.84	0.55
I know how to increase students' long-term interest in science.	262	2.65	0.57
It is not the teacher's responsibility to increase students' long-term interest in science. *	266	3.5	0.59
I have the skills to increase students' long-term interest in science.	262	2.92	0.45
My university program has not prepared me with strategies to increase students' long-term interest in science. *	266	2.87	0.75
I know how to motivate students' general interest in science.	262	2.94	0.46
If I had students who did not like science, I am sure I could get them to like science.	264	2.76	0.52
My university program has prepared me well to enthuse students about science.	265	2.81	0.62
I believe I can help students develop an enjoyment of science.	264	3.07	0.39
I am confident that my future students will learn to love science.	264	2.89	0.51
I am responsible for maximizing my students' interest in science.	264	3.21	0.61

*Reverse coded item for analyses

4.3 Scale Development

A Principal Components Factor Analysis was conducted on the twelve items (see Appendix F for factor analysis). This type of analysis extracts factors to account for the maximum amount of variance. Two main factors were extracted, accounting for 32.84% and 12.60% of the variance respectively. Only the first factor was retained. It contained nine items, all with loadings greater than 0.4 on the first factor. Nine variables were selected for inclusion in the first factor, using a cut-off point of greater than 0.5 on the first factor and less than 0.4 on the second factor. The nine items and their factor loadings are presented in Table 4.3.

Table 4.3
Items retained in the factor analysis

	Factor Loading
I do not have the strategies to enhance students' general liking for science (reversed coded).	0.67
I know how to increase students' long-term interest in science.	0.65
I have the skills to increase students' long-term interest in science.	0.65
I know how to motivate students' general interest in science.	0.61
If I had students who did not like science, I am sure I could get them to like science.	0.54
My university program has prepared me well to enthuse students about science.	0.66
I believe I can help students develop an enjoyment of science.	0.55
I am confident that my future students will learn to love science.	0.67
My university program has not prepared me with the strategies to increase students' long-term interest in science (reverse coded).	0.65

To examine the internal consistency of the scale developed from the factor analysis, a reliability test was conducted. The Cronbach's Alpha reliability score for the nine items was

0.82. Inspection of these nine items showed they all related to preservice teachers' confidence, or self-efficacy, that they could increase their students' interest in science. As a result, the scale was labelled "Efficacy to Enhance Student Interest in Science"

4.4 Independent Samples T-tests

An independent samples t-test was conducted to compare confidence to teach science between preservice primary teachers and preservice secondary science teachers. There was no significant difference between the preservice primary teachers (M=25.7, SD=3.22) and preservice secondary science teachers (M=25.35 SD=2.61); t ([252] =1.37, p=0.242).

Possible scores on the "Efficacy to enhance student interest in science" scale ranged from 9 (9 *1) to 36 (9 * 4) so that the mid-point on the scale was 22.5. Both primary and secondary teachers scored above the middle/average score of 22.5. One can conclude then that both preservice primary teachers and preservice secondary science teachers had similar (and above average) levels of confidence that they could increase their students' long-term interest in science.

4.4.1 Breakdown by educational grouping and year

A one-way ANOVA was conducted to compare differences in self-efficacy to increase interest among the four groups of students. The ANOVA was significant: f([252]=21.88, p=0.00). Exploring further, it emerged that there was a significant difference between the second-year primary teachers (M=27.22, SD=2.44) and the other groups, that is, the second-year secondary Masters students (M=24.77, SD=0.66), the third-year primary students, (M=24.16, SD=3.24), and the third-year secondary science students (M=25.59, SD=3.15). Table 4.4 shows the groups shows the differences among the four groups.

Table 4.4

Comparisons in "self-efficacy to enhance student interest in science" among preservice teacher groups

Main comparing group	Groups being compared	Sig
2nd year Primary Bachelor	3rd year bachelors	*
	2nd year Secondary masters	*
	3rd year Secondary bachelors	*
3rd year Primary bachelors	2nd year Primary Bachelor	*
	2nd year Secondary masters	**
	3rd year Secondary bachelors	**
2nd year Secondary masters	3rd year Primary Bachelor	**
	2nd year Primary Bachelor	**
	3rd year Secondary bachelors	**
3rd year Secondary bachelors	3rd year Primary Bachelor	**
	2nd year Primary Bachelor	**
	2nd year Secondary masters	**

* $p<0.05$

**$P>0.05$

The results show that second-year primary preservice teachers had greater confidence in their ability to increase students' interest in science than the other three groups. This result may be related to the timing of courses. The second-year primary preservice teachers completed the survey shortly after they had undertaken a course in how to teach science in the primary school. This course may have provided them with strategies to enhance their future students' interest in science.

4.5 Summary

To enhance the generalisability of the current study, a quantitative component was added. Both primary preservice teachers and secondary (science) preservice teachers completed the survey, though it should be noted that the number of primary students completing the survey was considerably higher than the number of secondary students completing the survey. This disparity in numbers was to be expected because the university where the survey was conducted prepares considerably more primary teachers than secondary science teachers.

A scale labelled "Self-efficacy to enhance student interest in science" was developed. The scale showed good internal reliability with an acceptably high Cronbach's Alpha score. When the primary preservice teachers were compared with the science specialist teachers (3rd year secondary preservice science teachers and 2nd year Master's preservice teachers), no difference in their self-efficacy to enhance student interest in science emerged. A one-way ANOVA showed that the 2nd year primary students had the highest self-efficacy of the four groups. All four groups had mean scores above the mid-score of the scale, so it can be concluded that, in general, participants in the survey were above average in their confidence that they could enhance students' interest in science.

In the next chapter, an analysis of the qualitative data of the study is presented.

Chapter Five

Qualitative Data Analysis

This chapter presents the results for the qualitative data collected in the study. Section 5.1 presents information from the open and closed ended parts of the questionnaire that addressed all three aims of the study. Section 5.2 presents the results from the interviews that addressed all three aims of the study. Section 5.3 presents the results from the classroom observations that were directed only to aim number three of the study; from where did primary and secondary (science) preservice teachers obtain their ideas for how to enhance students' long-term interest in science?

5.1 Open Ended Questions from the Questionnaire

The purpose of the open-ended questionnaire was to obtain the preservice teachers' opinions about how to change students' long-term interest in science and their explanations about where they obtained their ideas.

5.1.1 *Question One (Please list three classroom techniques you would use to increase students' long-term interest in science.)*

In response to this item only 3.7% of the total participants did not provide a response. This suggested that over 96% of the participants did have ideas about how to increase long-term interest in science. The responses were categorized using students' literal wording, rather than trying to interpret meaning. Table 5.1 shows the most common categories of response (i.e., those which represented more than 5% of responses from at least one of the groups). The most common category was "Hands-on Activities" which included responses such as practical activities and experiments. "Relevance" was coded for responses such as personal relevance and relating to real life. "Student-centred" was coded when responses included student-directed learning, collaborative learning, or group work. "Fun" was coded when responses included making lessons fun or interesting, but without stating exactly how. "ICT" was coded for responses that included any sort of electronic media. "Student Interests" was coded for responses that suggested relating the content to the pre-existing interests of the students. "Engagement" was coded when responses stated engagement of students, but without saying exactly how. The remainder of responses occurred with lower frequency, and included specific pedagogical techniques such as field excursions, stories, demonstrations, and discussion, as well as other factors such as teacher enthusiasm, novelty, variety, challenge, and interaction. None of the responses used the term "situational interest". The following were some representative responses for the main categories:

- Letting them to things that are practical so that they can see that side of science (male, third year primary, coded as Hands On.)
- Fuel their interest with what goes on in the world around them (male, second year primary, coded as Relevance)
- Letting them choose the experiment or the method – let them be the scientists (female, third year primary, coded as Student-centred)
- Explore fun and interesting science phenomena which enhance enjoyment (female, third year primary, coded as Fun)
- Integration of ICT – multimedia and games (female, secondary masters, coded as ICT

- Relating it back to students' personal interests (female, second year primary, coded as Student Interests)
- Create interest in science concepts through the creation of an engaging learning environment (female, third year primary, coded as Engagement)

Table 5.1

Main Themes Coded for Question 1 by The Number of Responses

Coded Themes	**Secondary U/G N=64***	**Secondary Masters P/G N=24***	**Primary 2nd year U/G N=323***	**Primary 3rd year U/G N=298***
Hands On	17%	33%	24%	31%
Relevance	11%	20%	13%	15%
Student Centred	11%	21%	9%	11%
Fun	2%	0%	8%	9%
ICT	13%	8%	2%	5%
Student Interest	8%	8%	8%	5%
Engagement	8%	0%	5%	6%
Other (minor categories)	30%	10%	31%	18%

*Number of responses per educational group

5.1.2 Question Two (For students to develop a long-term interest in science, how often should they experience those classroom techniques?)

The main categories identified in response to this question are shown in Table 4. This table shows the most common category for this question was coded as Often and responses in this category included statements such as “3 times a week” “2 times a week”, “weekly”. The less regularly category was created to accommodate responses that were not Often or weekly for instance “Once a fortnight.”

Table 5.2

Frequency of Use of Classroom Techniques

Category	**Percentage%** **N=267**
Often (i.e. Once a week or more)	88
Less Regularly (less than once per week)	0.75
Not Clear/Unsure	7.15
Did not answer	4.10

The main reason for the Not Clear/Unsure category was because was because the responses were not clear enough to be placed in the everyday, every lesson or regular categories. Table 5.2 shows that the majority of the respondents stated that those classroom techniques which they identified for increasing their students’ long-term interest in science should in terms of frequency be used “Often”, that means once per week or more.

5.1.3. Question Three (From where did you acquire your ideas about how to increase students' long-term interest in science?)

In response to this item, many students referred to two or three influences. Table 5.3 shows the most common categories of response (i.e., those which represented more than 5% of responses from at least one of the groups). The most common category was "University Courses" which was coded when students stated university or specific courses at university, without stating what it was about those courses. "Teaching Practicum" was coded for any in-school teaching experiences. "Personal Experience" was coded when responses indicated personal experience but without describing the nature of that personal experience. "Prior Schooling" was coded when responses indicated personal experiences at primary or secondary school. "Electronic Media" was coded for references to YouTube, the internet, or television. The Other category were responses that occurred with lower frequency, and included influences of friends and family, including students' own children, informal science centres, personal ideas, and not clear responses. None of the responses specifically referred to the research on the development of long-term interest or individual interest. The following were some representative responses for the main categories:

- Making lessons engaging will increase their interest, so using the classroom techniques taught in university (female, third year primary, coded as University Courses);
- The engagement techniques we learnt from my second year prac teacher (female, third year primary, coded as Teaching Practicum);

- Relating science to my own life made me appreciate science more. Therefore, I believe if students relate to it well they’ll enjoy lifelong science learning (female, third year primary, coded as Personal Experience);
- Personal schooling experience. . . Science…Remembering lessons I have been given (female, third year primary, coded as Prior Schooling);
- Online – YouTube teacher resource pages (male, third year Primary, coded as Electronic Media);
- From my family, my children are my inspiration (female, third year primary coded as Other).

Table 5.3

Main Themes Coded for Question 3 by the Number of Responses

Category	**2nd Year Primary** N=260	**3rd Year Primary** N=231	**Secondary Undergraduate** N=55	**Secondary Masters** N=19
University Courses	47%	41%	38%	37%
Teaching Practicum	15%	13%	13%	26%
Personal Experience	7%	8%	16%	11%
Prior Schooling	14%	13%	11%	16%
Electronic Media	8%	13%	9%	5%
Other	9%	12%	13%	5%

5.2 Interviews

The main purpose of the interview was to provide additional evidence in relation to the following aims:

1. How do primary and secondary (science) preservice teachers believe they can enhance students' long-term interest in science?

2. What are primary and secondary (science) preservice teachers' ideas for how to enhance students' long-term interest in science?
3. From where did primary and secondary (science) preservice teachers obtain their ideas for how to enhance students' long-term interest in science?

5.2.1 Question One **(***On a scale of 1-10 with 10 being the highest how would you rate your level of confidence for increasing your students' long-term interest when you become a teacher?)*

Responses to this question are shown in Table 5.4. Nearly all the interviewees were in the positive range for confidence, although there was more variation among the primary group. Apart from this difference in the spread of responses, no major differences were apparent between primary preservice teachers and preservice secondary science teachers.

Table 5.4

Level of Confidence and Educational Category

Level of confidence	Primary	Secondary
8-10 (high)	3	0
5-7 (moderate)	4	4
3-4 (low)	1	0
1-2 (very low)	0	0

5.2.2 Question Two (How would you improve your students' long-term interest in science?)

In response to this interview question 11 of the 13 interviewees mentioned hands-on activities, and other suggestions such as real-life relevance, engagement, relating to students' interests, media, fun activities, and student-centred group work were commonly cited. In this way, the interviews triangulated well with the results of the questionnaire. None of the interviewees mentioned situational interest or described a developmental relationship between states of interest and long-term interest. The following were some representative examples of their responses;

- I believe that a more interactive class is a more engaging class, is a class that will get them vested in their interest . . . The more *practical* it is the more engaging it will be and the more interest will be invested. (male secondary coded for Hands-On);
- I know students will have observed phenomena in real life and actual world... I mean using those phenomena that they have observed or be aware of but not fully understand, and [teachers should] provide the links between what they have observed and their understanding (male secondary, coded for Relevance);
- To get their interest I think you've definitely got to ensure that they are engaging . . . You have to get them really thinking about it, so you've got to do something that for them they're gonna look at and go wow I haven't seen it [before] – I haven't thought about it this way. . . Through that engagement I think their interest will come (male secondary, coded for Engagement);
- Some things about the world and science that interest the kids you are teaching, so they can enjoy it more. . . The kids might be really interested about human anatomy. Might be interested about astronomy (female primary, coded for Student Interests);

- I like the idea of exposing them to science media that is tailored to a younger and perhaps regular audience . . . to perhaps broaden their ideas and learn things that are outside the syllabus . . . I don't want it to begin and end with me in the classroom, but I want to be able to provide them with links to further or different aspects of science (male secondary, coded for Media);
- By showing them the fun side of science like letting them play games that are science based. (male, third year primary coded for Fun).

5.2.3 Question Three (From where did you get your ideas for how to increase students' long-term interest in science?

In response to this question, 12 of the 13 interviewees mentioned university courses in teacher education. Other sources included prior schooling, teaching practicum, electronic media, other students/family/friends, and their own interest. In this way, the interviews triangulated well with the results of the open-ended survey. None of the interviewees mentioned the research on the development of long-term interest. The following were some representative examples of the main responses:

- Learning what I have been taught at uni . . . the way that he talked about engaging students with a lot of hands on activities. I know that in that class we did a lot of hands on activities. How to engage students and be explicit in our teaching of science (third year primary female, coded for University Courses);
- When I was doing it back in primary school and even high school I think, I learnt a lot more from doing experiments . . . I always found them interesting and I figured I could

have that similar effect on the students that I want to teach later on (third year primary male, coded for Prior Schooling);

- Being in the classroom for four weeks and interacting with another science teacher. That provided me with more of an insight into how I might engage the students better with regards to science (third year secondary undergraduate female, coded for Teaching Practicum);
- On social media where you see the flashier science experiments which are interesting to look at . . . Because you see people's interest on social media for things like that and you think if people just in the everyday are interested in it surely there's a way to take that and apply the interest to students as well (male third year primary, coded for Electronic Media);
- From seeing how myself, friends and students react to different methods of teaching science and seeing what motivates them more to learn (female, secondary undergraduate, coded as Other Students/family/friends);
- My general curiosity and interest in learning how things work (male, third year primary, coded as Own Interest)

5.3 Classroom Observations

The purpose of the observation was to find out whether there were interest-arousing experiences occurring during the lectures and tutorials in the university courses, since the results had suggested that these were a major source of their ideas for how to increase students' long-term interest in science.

The observation checklist indicated that many potential sources of situational interest had occurred during the lecture and two tutorials/workshops. Figure 1 shows the frequency with which involvement, relevance/meaningfulness, and novelty were recorded in each session. It shows that the primary science lecture had relatively low levels of student involvement, as there was relatively little interaction with each other or with the instructor. However, the lecture did contain high levels of novelty, as the instructor/lecturer frequently made use of interesting pictures, surprising facts (e.g., astronaut diapers), and demonstrations of discrepant events (e.g., a cup of water with a hole in it will retain the water while falling, thereby modelling weightlessness). On the other hand, the primary science methods tutorial session had higher levels of involvement, as the students asked and answered questions, and worked together in groups to carry out hands-on activities on the topic of magnetism. Meaningfulness was recorded as the instructor provided information about how to present the activities in a primary school setting, and novelty was recorded when the activities had unusual or surprising features (e.g., using a magnetic field to suspend a paperclip in mid-air). According to the notes made by the observer, the students appeared to be highly interested during the workshop session, as they could be heard laughing in enjoyment and making comments such as “It’s so cool!”. In the secondary science methods tutorial session, there were higher levels of meaningfulness since the lecturer provided information about how the content being learnt is of direct importance to the secondary school setting. Involvement and novelty in the secondary science methods tutorial were very low.

In summary, the classroom observations suggested that the lecture and tutorials did contain multiple opportunities for students to experience a state of interest. If these teaching sessions were typical (and there was no reason to assume that they were not) then this suggests that the primary and secondary students would have had many opportunities to experience enhanced interest during their science education studies. These data therefore triangulate well with the results of the questionnaires and interviews, as they confirm that these students could potentially have had personal experience of interest arousal during their university studies in science education.

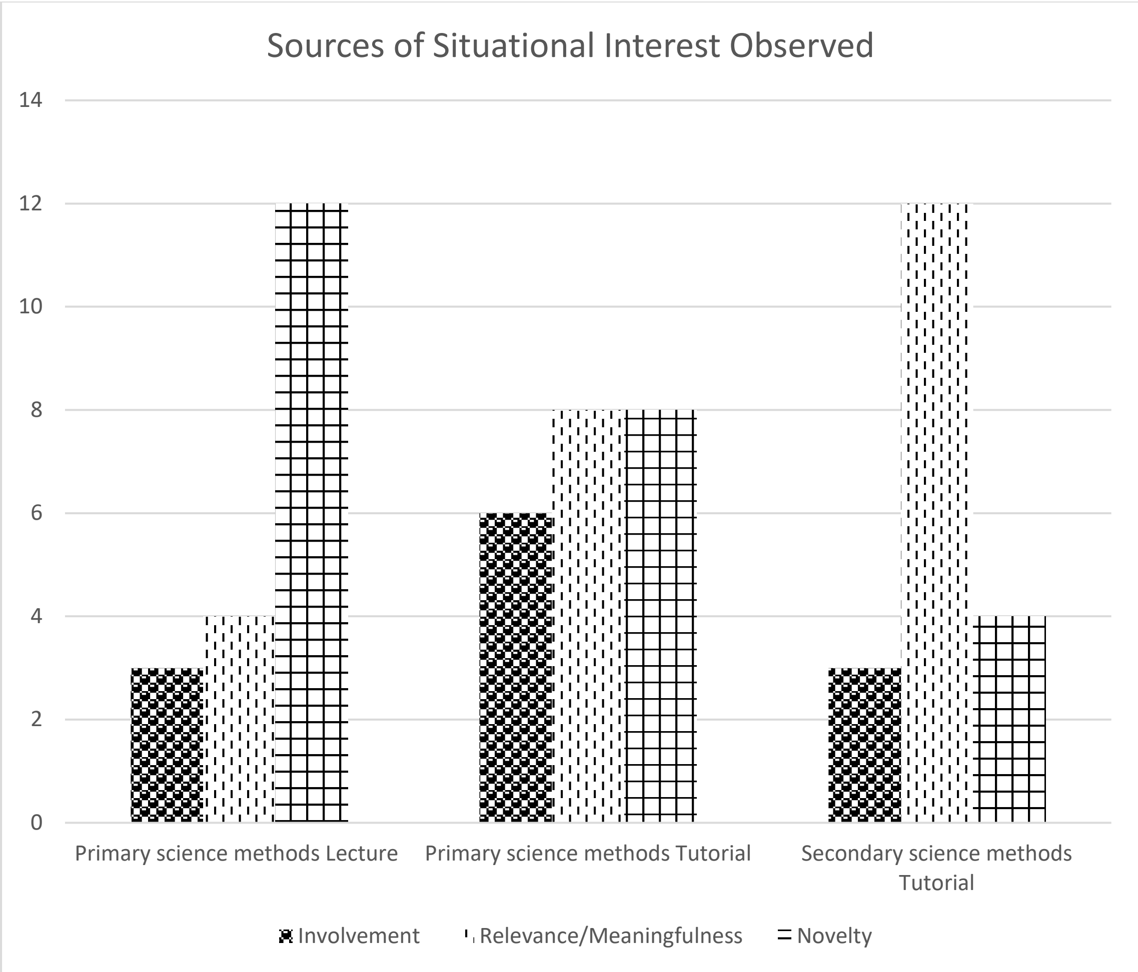

Figure 1. Sources of Situational Interest Observed During Lesson Observations.

Chapter Six

Discussion

6.1 Introduction

This chapter presents the discussion of the main themes found in the study. The study was designed to investigate preservice teachers' perceptions for how to increase students' long-term interest in science. The research aims of the study were as follows;

1. How do primary and secondary (science) preservice teachers believe they can enhance students' long-term interest in science?
2. What are primary and secondary (science) preservice teachers' ideas for how to enhance students' long-term interest in science?
3. From where did primary and secondary (science) preservice teachers obtain their ideas for how to enhance students' long-term interest in science?

In Sections 6.2, 6.3 and 6.4 the aims number one, two and three are discussed respectively, with reference to the literature. In Section 6.5 the limitations of the study are explained.

6.2 How do Primary and Secondary (Science) Preservice Teachers Believe they can Enhance Students' Long-term Interest in Science?

Data in relation to this aim were retrieved from the quantitative survey and the interviews with primary and secondary preservice teachers.

6.2.1 Primary

From the quantitative survey, it was found that both groups of preservice primary teachers had a positive level of confidence that they could increase their students' long-term interest in science. The interviews also revealed that the preservice primary teachers were quite confident that they could increase their students' interest in science. These two data sources therefore triangulated well, suggesting an acceptable level of validity for these results. According to the survey results, the second-year cohort had a higher level of confidence than the third-year cohort. This may have been because the second years were currently participating in their science methods courses, so their experience would have been more recent than that of the third years who had completed their science methods the preceding year.

Unfortunately, there have been no previous studies of preservice primary teachers' confidence (or self-efficacy) that they can change their students' interest in science. However, a pattern of low confidence for teaching science has been found amongst primary school teachers. The Australian Academy of Science (2012) indicated that "Many writers have argued that primary teachers' limited science background erodes their confidence to teach science" (p.194). This is of concern because Sarikaya (2004) indicated that the teacher who has a low level of confidence tends to be reluctant to teach science. Similarly, Appleton (2003) reported that one of the major reasons why elementary teachers avoid teaching science was because of a lack of confidence to teach the subject.

On the other hand, it has been found that preservice primary teachers can develop moderate to high confidence (self-efficacy) for science teaching, due to their experiences in science methods courses. In a study about nurturing preservice teachers' confidence in science, conducted by Bleicher (2007) it was found that "preservice teachers were not only perceiving higher science teaching self-efficacy, but also felt that their teaching would make a difference to student achievement" (p. 854). Similarly, Watters and Ginns (2000) argued that science methods courses can be effective in enhancing preservice primary teachers' confidence to teach science. The results of the present study are not directly comparable to these but they do indicate a similar pattern of moderately high confidence/efficacy among preservice primary teachers who have participated in science methods courses.

6.2.2 Secondary

From the quantitative survey, it was found that preservice secondary teachers had a moderately positive level of confidence that they could increase their students' long-term interest in science. The interviews also revealed that the preservice secondary teachers were moderately confident that they could increase their students' interest in science. These two data sources therefore triangulated well in providing validity to these results.

Unfortunately, there have been no previous studies of preservice secondary teachers' confidence or self-efficacy that they can change their students' interest in science. However, preservice secondary science teachers have chosen to be science specialists, and they usually have positive attitudes towards science and science teaching in general (Akbulut & Karakuş, 2011; Ates & Saylan, 2015). Although the present study is not directly comparable to these, the findings are generally similar in suggesting a moderately positive level of confidence.

6.2.3 Comparison Between Primary and Secondary Results

The preservice primary teachers and the preservice secondary teachers in this study had very similar levels of confidence that they could enhance future students' long-term interest in science. Previous studies have not compared primary and secondary preservice teachers' confidence that they can enhance future students' interest in science. However, there has been some previous evidence that concerns confidence for teaching science rather than confidence to enhance interest in science. For example, Anderson, Bartholomew, and Moeed (2009) reported that, "All secondary and nearly all primary teachers (29/33) ... indicated that they were confident or very confident about their ability to teach science" (p.5).

In the present study, the similar levels of confidence between primary and secondary are interesting because it might be expected that's preservice secondary teachers would have a higher confidence/efficacy for all aspects of teaching science, because they are science specialists. However, this was not the case. One possible explanation for this might be that the secondary preservice teachers may have given little thought as to how to increase their future students' interest in science. Silvia (2001) for example, warned that most people who have strong interests give little thought as to how their interests develop–they enjoy their interests but are disinclined to question from where they came. On the other hand, the preservice primary teachers may have had recent, personal experience of the development of their own interest due to participation in their science methods courses. Jarrett (1999) for example, reported that preservice primary teachers could develop enhanced interest in science through participation in a well-designed science methods course. In this way, the roughly equal levels of confidence between the primary and secondary groups may have been due on the one hand to recent personal experience in interest development, which may have led the primary preservice teachers to believe they could achieve the same result with their future students; whereas on the other hand, the secondary preservice teachers may have thought little about the processes involved despite their own well-established interest in the subject.

6.3 What are Primary and Secondary (Science) Preservice Teachers' Ideas for how to Enhance Students' Long-term Interest in Science?

Data in relation to this aim were retrieved from the open-ended questionnaire and the interviews. A striking finding from the results was that although the participants had been consistently asked how to develop *long-term* interest in science, their responses almost exclusively included techniques for short-term arousal of interest. In other words, the strategies were suggestive of situational interest rather than individual interest. For example, Hands-on (including practical activities and experiments) was by far the most frequent response category. According to the literature however, hands-on activities are a source of *situational interest* (Dohn, 2013).

Similar reasoning can be applied to the other categories. Two of the other categories were Relevance (including personal relevance and relevance to real life) and Student Interests (relating the content to the pre-existing interests of the students). Both of these can be interpreted as representing *meaningfulness*, which is a source of situational interest that occurs when the content is perceived as being important in real life, valuable, or of personal relevance (Hidi & Renninger, 2006; Mitchell, 1993). Other categories included Student-centred (including student-directed learning, collaborative learning, or group work) and Engagement. Both of these can be interpreted as indicating *involvement*, which occurs when students are active participants in learning (Hidi & Renninger, 2006; Mitchell, 1993). Another category was Media, which was coded for responses including multimedia, YouTube videos, and online games, yet online activities involving *computers* have been identified as sources of situational interest (Hidi & Renninger, 2006; Mitchell, 1993; Tapola, Jaakkola, & Niemivirta, 2013). Finally, the category of Fun was coded when responses suggested making the lessons fun or interesting. This also suggests situational interest because an interesting or fun experience in a lesson is suggestive of positive affect associated with situational interest experience (Renninger & Hidi, 2016). Thus, the participants' ideas for how to enhance long-term interest were highly suggestive of situational interest.

An interesting pattern emerges when these findings are put together with the responses to the second question in the questionnaire, in which participants were asked *how often* students should experience those techniques in order to develop a long-term interest in science. Nearly all the responses to this question were similar in suggesting that it should occur frequently (i.e., at least once per week or at least once per lesson). Thus, the responses to this question can be interpreted as indicating that regular experiences of situational interest would lead to long-term interest. This idea is roughly in line with current theory which holds that repeated experiences of situational interest in a subject area are necessary to promote the development of individual interest (Rotgans & Schmidt, 2017). It can therefore be concluded that these preservice teachers did have a workable knowledge, at least from a practitioner's point of view, about how to enhance students' long-term interest in science. This is a welcome finding, given the problem of students' declining interest in science, because it suggests that these future teachers will at least have a workable understanding of how to attack the issue.

6.4 From Where Did Primary and Secondary (Science) Preservice Teachers Obtain their Ideas for How to Enhance Students' Long-term Interest in Science?

Data in relation to this aim were retrieved from the open-ended questionnaire and the interviews. Perhaps the most telling finding in relation to this question was that none of the questionnaire or interview responses made any reference to the research literature on the development of individual interest, and nor were technical terms such as "situational interest" or "individual interest" used by the participants. This suggests that participants were using their *intuitive* ideas about this issue.

These ideas came from several sources. The most common category was University, and the interview and questionnaire responses suggested that, in the science education courses, participants had been taught classroom techniques that would interest school students (i.e., that would arouse short-term interest during lessons). Importantly, some of the comments from the primary group indicated that *personal experience* with these techniques (such as hands-on activities) had been interesting for the primary participants (e.g., "I learnt it in my tutorials, as I personally was interested in the activities. At school, I wasn't interested in science so I would like to work on it for my students", female, primary). These types of responses (the quotes are provided here in order to support the particular argument) suggested that at least some of the effect of the workshops in the primary program was that participants themselves had experienced a short-term arousal of interest, on occasion. The science courses in this study were not unusual in this respect, as other studies have also reported that preservice primary teachers are often exposed to a range of interesting hands-on activities during their science education studies (Palmer, Dixon, & Archer, 2016). The present study has suggested that these personal experiences had provided the participants with ideas for how to enhance future students' interest in science.

Prior Schooling was another source that provided personal experience of interest arousal. Some of the comments in this category suggested that students had personally experienced short-term triggering of interest (e.g., "When I was doing it back in primary school and even high school I think, I learnt a lot more from doing experiments . . . I always found them interesting and I figured I could have that similar effect on the students that I want to teach later on", male, primary). In addition, some participants appeared to have developed long-term interest from their schooling experiences (e.g., "They are techniques I remember from school, and the reason why I enjoy science”, female, primary). Other studies have revealed that preservice teachers’ experiences at school can have powerful influences on their interest in science (Jarrett, 1999), but the present study has suggested that these can also be a source of their ideas for how to enhance future students’ interest in science.

Some other categories can also be inferred to have included personal experience. Media for example, could be a source of personal experience of situational interest (e.g., “Videos on YouTube combined with my basic knowledge of physics has triggered my interest and I could encourage students in the same way”, male, primary). Similarly, Personal Experience was coded as a category itself when the source of the personal experience was not stated (e.g., “Personal experience (what I enjoyed). By thinking of what did/didn’t inspire me”, female, primary). This evidence suggest that the participants were drawing strongly upon their own personal experiences of interest as a source of their ideas. Intuitive ideas are those that are based on personal experience rather than an understanding of theory (Wood, Galloway, & Hardy, 2016), and the strong influence of personal experience in these responses provides further evidence that these were intuitive ideas.

Other responses suggested that *vicarious experience* of interest arousal had also been a source of their ideas. For example, Practicum was coded when participants stated that their practice teaching placements in school had been a source of ideas for how to enhance student interest. One reason given was that they had observed how interested the students became when appropriate techniques were used (e.g., “Through practical experience using techniques taught in university and experiencing at first-hand what students enjoy”, female, primary). Similarly, some of the Media responses suggested a vicarious experience had occurred (e.g., “On social media where you see the flashier science experiments which are interesting to look at . . . Because you see people’s interest on social media for things like that and you think if people just in the everyday are interested in it surely there’s a way to take that and apply the interest to students as well”, male, primary). Thus, seeing evidence of interest aroused in other people was a source of participants’ ideas for how to enhance interest. Vicarious experience is known to be an important source of efficacy information (Bandura, 1997), but the present study has suggested it can also be a source of interest information.

6.5 Limitations

During this study, there were limitations which should be considered when interpreting the results, as follows:

1. It cannot be assumed that the results of the study will be generalizable to other preservice teachers at another university since it is not known whether those other preservice teachers are explicitly taught how to increase their students’ long-term interest in science at each university.
2. The primary science education courses were taught by enthusiastic instructors who were well aware that many of these preservice teachers would have less than positive attitudes towards science, so they made efforts to tailor instruction by including many experiences that were intended to arouse science interest among this group. In this way, the participants’ experiences in these courses gave them ideas for how to enhance interest. However, the extent to which this approach is comparable to that in other primary teacher education programs might vary according to how each one is presented.
3. This study purposely focused on the ideas of preservice teachers, because these individuals will be charged with addressing future problems in science education. However, ideas do not necessarily equate with future implementation. When these individuals enter schools, and begin their careers as teachers they will face restraints

such as the demands of a crowded curriculum and the necessity to prepare students for external testing. The extent to which these might interfere with their ability to implement their ideas for enhancing student interest in science should also be considered.

Chapter Seven

Conclusion and Implications

This chapter presents the conclusions in Section 7.1 and the implications for teaching and future research in Section 7.2. The three research questions which were addressed in this study were:

1. How do primary and secondary (science) preservice teachers believe they can enhance students' long-term interest in science?
2. What are primary and secondary (science) preservice teachers' ideas for how to enhance students' long-term interest in science?
3. From where did primary and secondary (science) preservice teachers obtain their ideas for how to enhance students' long-term interest in science?

7.1 Conclusions

Based on the findings, the following conclusions can be drawn:

1. As shown in section 5.2.1, the primary and secondary (science) preservice teachers actually believe they can enhance students' long-term interest in science. The results showed that the 2nd year primary preservice teachers were the most confident for increasing their students' long-term interest in science.
2. As shown in sections 5.1.1 and 5.2.2, with regards to the preservice teachers' ideas for how to enhance students' long-term interest in science, the primary and secondary

science preservice teachers suggested experiences that implied situational interest, and they suggested these should be used often. Some of those ideas included, using ICT/media, using hands on activities, using fun/interesting activities, making science relevant to the students. By comparison with the literature, this would probably enhance students' long-term interest in science. However, the preservice teachers didn't refer to the theory or use terms like situational interest or individual interest.

3. As shown in sections 5.13,5.2.3, and 5.3, the preservice teachers indicated that they obtained their ideas for how to enhance student interest in science mainly from their university studies, practicum teaching, personal experiences, ICT/Media, (Social media) and friends/ family. The lack of reference to research findings indicated that their ideas were probably not obtained from a knowledge of the research on individual and situational interest.

The results of this study are hopeful because they indicate that preservice teachers have workable ideas for how to increase student interest in science and if they are able and allowed to practice those techniques in the classroom when they become teachers then this should help to curb the decline in interest in science among primary and secondary students.

7.2 Implications

The findings of this research were found to have the following implications;

7.2.1 Implications for Teaching

One implication for teaching is that preservice teachers' personal experiences of interest in science can play a major role in determining their ideas about how to approach this issue among their future students. Hence, it is important to provide both primary and secondary preservice teachers with lots of experiences in which they can personally feel their own interest to be aroused. It is these regular experiences of situational interest in their teacher education courses that can build this fund of experience. This is especially important among primary preservice teachers, many of whom will enter the university program with ambivalent attitudes towards science. Direct experience with this type of teaching could also be expected to benefit the preservice secondary science teachers–paradoxically, it was found that these individuals were less likely to refer to personal experience as a source of their ideas–so perhaps they would benefit from recent experiences that would not only consolidate their own interest in science, but would also be relevant to secondary science teaching. It should be emphasized however, that the main message arising from this study is a very positive one, because these future science educators appeared to have developed a workable body of ideas about how to address an important issue in schools.

7.2.2 Implications for Future Research

A longitudinal study should be undertaken to investigate pre-service teachers' efficacy for increasing student interest during their university years including their actual in-service teaching. This will provide an insight into whether there is a change in their efficacy for increasing student interest. A longitudinal study can aid a researcher in revealing strategies that can be used to increase teachers' efficacy for increasing student long-term interest in science.

A second avenue for research would be to compare different teacher education institutions regarding the extent to which the preservice teachers' ideas for how to enhance long-term interest in science may be affected by the way science and science methods are taught at different institutions. In particular, it would be very instructive to discover whether explicit teaching of the theory of interest development might enhance the quality of preservice teachers' ideas.

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Appendices

Appendix A

Information Statement

Associate Professor David Palmer
Faculty of Education and Arts
The University of Newcastle
Phone: (+61) 2 49216705
Fax: (+61) 2 4921 6895

THE UNIVERSITY OF
NEWCASTLE
AUSTRALIA

PRESERVICE TEACHERS' KNOWLEDGE OF HOW TO ENHANCE CHILDREN'S AND ADOLESCENTS' INTEREST IN SCIENCE

Associate Professor David Palmer
Project Supervisor

Dr Jennifer Archer
Project Co-supervisor

Davis Jean Baptiste
Research Student

Document Version 1. Dated 4/05/16

Dear Preservice Teacher,

You are invited to participate in the research project identified above which is being conducted by Associate Professor David Palmer from the School of Education. The research is part of Davis Jn. Baptiste's studies for the degree of Master of Philosophy, supervised by Associate Professor David Palmer and Dr Jennifer Archer.

Why is the research being done?
The purpose is to examine preservice teachers' knowledge of the strategies and techniques used to enhance children's and adolescents' interest in science.

Who can participate in the research?
We are seeking the participation of preservice primary teachers and secondary science teachers at the University of Newcastle.

What choice do you have?
Participation in this research project is entirely your choice. If you do not want to participate, you do not have to answer any questions in the attached questionnaire and you do not have to participate in an interview. Whether or not you decide to participate, your decision will not disadvantage you. If you do decide to participate, you also have a right to withdraw from the interview part of the project at any time without giving a reason and have the option of withdrawing any data that identifies you. With regards to the surveys, since they are

anonymous, you will not be able to withdraw your survey responses after the survey has been returned.

What would you be asked to do?
This project consists of two components: a 10 minute questionnaire and a 20 minute interview.

We are asking all preservice primary teachers and secondary science teachers to complete the questionnaire. We hope that a smaller number of preservice primary teachers and secondary science teachers will agree to participate in an interview.

If you are willing to take part in an interview
Please email David Palmer (David.Palmer@newcastle.edu.au) if you are willing to participate in an individual interview of approximately 20 minutes. Alternatively, complete the consent to be interviewed form and leave it in the box where completed questionnaires are deposited. The interview will be conducted by Davis Jean-Baptiste in a room at the university. The interview will be recorded and be conducted at a time that suits you.

In the event that more preservice teachers volunteer than can be accommodated, the researcher will interview the first 10 primary and the first 10 secondary students who send a response. During the interview, the researcher will ask you about your knowledge of strategies to enhance children's and adolescents' interest in science and where you found out about those strategies.

How much time will it take?
The questionnaire should take approximately 10 minutes to complete. The interview should last approximately 20 minutes.

What are the risks and benefits of participating?
There are no risks or benefits to your participation in this research. However, we hope that there will be long-term benefits for science teaching and teacher education.

How will your privacy be protected?
The questionnaire is anonymous. It will not be possible identify you by your responses.

For the interviews, the names of participants will not be released in any report of the project. When we transcribe the audiotapes, your name will be replaced with a numerical code. References to people or organizations will be blanked out. You will be offered the opportunity to review, edit, or erase your contribution. Any information that might identify you will be stored securely and only accessed by the project supervisor, co supervisor, and the research student except as required by law.

How will the information collected be used?
Information will be used in a thesis to be submitted by Davis Jean-Baptiste, in papers published in academic journals, and in presentations at conferences. A report of the study will be provided

to the University of Newcastle. A summary of the findings of the research project will be placed on Blackboard course sites (for courses where participants are likely to be enrolled in 2017).

What do you need to participate?

Please read this information statement and be sure you understand its contents before you decide to participate. If there is anything you do not understand, or you have questions, please contact the researcher.

Completing the questionnaire

If you agree to complete the questionnaire, please complete it and put it in the secure labelled box located at the School of Education Office. Returning the completed questionnaire will be taken as your consent to participate.

Participating in the interview

If you would like to participate in an interview, please complete and return the attached consent form to the secure collection box located in the School of Education Office or email David.Palmer@newcastle.edu.au. We then will contact you to arrange times suitable to you for an interview.

Further Information

If you would like further information before you make a decision, please contact Davis Jean Baptiste (c3217964@uon.edu.au or +61 0405521455) or Associate Professor David Palmer on email david.palmer@newcastle.edu.au

Thank you for considering this invitation.

Associate Professor David Palmer	Davis Jean-Baptiste
Project Supervisor	Research Student

This project has been approved by the University's Human Research Ethics Committee, Approval No. H- [2016-0169].

Should you have a complaint about the manner in which the research is conducted, it may be given to the researcher, or, if an independent person is preferred, to the Human Research Ethics Officer, Research Office, The Chancellery, The University of Newcastle, University Drive, Callaghan NSW 2308, Australia, telephone (02) 49216333, email Human-Ethics@newcastle.edu.au.

Appendix B

Consent Form

Associate Professor David Palmer
The University of Newcastle
Callaghan, NSW 2308, Australia
Phone: (+61) 2 49216705
Fax: (+61) 2 4921 6895

Consent Form:
PRESERVICE TEACHERS' KNOWLEDGE OF HOW TO ENHANCE CHILDREN'S AND ADOLESCENTS' INTEREST IN SCIENCE

Associate Professor David Palmer
Project Supervisor

Dr Jennifer Archer
Project Co-supervisor

Davis Jean-Baptiste
Research Student

Document Version 1.1 Dated 8/06/2016

I agree to participate in the above research project and give my consent freely.

I understand that the project will be conducted as described in the Information Statement, a copy of which I have retained.

I understand I can withdraw from the interview at any time and do not have to give any reason for withdrawing.

I consent to participate in a 20-minute interview.

I understand that my personal information will remain confidential to the researchers.

I have had the opportunity to have questions answered to my satisfaction.

Print Name: ____

Signature: ________________________Date: ____________________

Please provide your contact details so we can arrange a time for an interview.

Phone Number: ___________________ Email Address_________________________________

This project has been approved by the University's Human Research Ethics Committee, Approval No. H- [2016-0169]

Should you have a complaint about the manner in which the research is conducted, it may be given to the researcher, or, if an independent person is preferred, to the Human Research Ethics Officer, Research Office, The Chancellery, The University of Newcastle, University Drive, Callaghan NSW 2308, Australia, telephone (02) 49216333, email Human-Ethics@newcastle.edu.au.

Appendix C

Questionnaire Survey

Associate Professor David Palmer
The University of Newcastle
Callaghan, NSW 2308, Australia
Phone: (+61) 2 49216705
Fax: (+61) 2 4921 6895

PRESERVICE TEACHERS' KNOWLEDGE OF HOW TO ENHANCE CHILDREN'S AND ADOLESCENTS' INTEREST IN SCIENCE

Sex: Male_____ Female______ Transgender/Intersex/Unspecified______

Please indicate the degree to which you agree with each statement by placing an X in the appropriate box.
KEY: SD=STRONGLY, D=DISAGREE, A= AGREE, SA= STRONGLY

	SD	D	A	SA
It is important for teachers to increase students' long-term interest in science.				
I do not have the strategies to enhance students' general liking for science.				
I know how to increase students' long-term interest in science.				
It is not the teacher's responsibility to increase students' long-term interest in science.				
I have the skills to increase students' long-term interest in science.				
My university program has not prepared me with strategies to increase students' long-term interest in science				
I know how to motivate students' general interest in science.				
If I had students who did not like science, I am sure I could get them to like science.				
My university program has prepared me well to enthuse students about science.				
I believe I can help students develop an enjoyment of science.				
I am confident that my future students will learn to love science.				
I am responsible for maximizing my students' interest in science.				

Please list three classroom techniques you would use to increase students' long-term interest in science

1. ______________________________
2. ______________________________
3. ______________________________

For students to develop a long-term interest in science, how often should they experience those classroom techniques?

____

From where did you acquire your ideas about how to increase students' long-term interest in science?

____

____

____

Thank you very much for participating in this survey

Appendix D

Interview Protocol

Associate Professor David Palmer
The University of Newcastle
Callaghan, NSW 2308, Australia
Phone: (+61) 2 49216705
Fax: (+61) 2 4921 6895

PRESERVICE TEACHERS' KNOWLEDGE OF HOW TO ENHANCE CHILDREN'S AND ADOLESCENTS' INTEREST IN SCIENCE

Interview Protocol

Venue: ____________________

Program: ____________________

Year Level ____________________

Interview Questions

1. Do you feel confident that you could increase your students' long-term interest in science when you become a teacher?
2. On a scale of 1-10 with 10 being the highest how confident are you that you can increase your students' long-term interest in science when you become a teacher? (Please explain)
3. How would you improve your students' long-term interest in science?
   Is there anything else you would do? (Can you explain each one?)
4. From where did you get your ideas for how to increase your student's long-term interest in science?

Thank you very much

Appendix E

Classroom Observation Checklist

Associate Professor David Palmer
Faculty of Education and Arts
The University of Newcastle
Phone: (+61) 2 49216705
Fax: (+61) 2 4921 6895

Time	Novelty	Involvement	Relevance/meaningfulness
3			
6			
9			
12			
15			
18			
21			
24			
27			
30			
33			

Appendix F

Principal Components Factor Analysis

Factor Analysis

Descriptive Statistics

	Mean	Std. Deviation	Analysis N
It is important for teachers to increase students long-term interest	3.5458	.52999	251
I do not have strategies to enhance liking for science	2.8367	.55965	251
I know how to increase students' long-term interest in science	2.6375	.57274	251
It is not the teachers' responsibility to increase students' long-term interest in science	3.4980	.59582	251
I have the skills to increase students long-term interest in science	2.9243	.45414	251
My university has not prepared me with strategies to increase students' long-term interest in science	2.8805	.76004	251
I know how to motivate students' general interest in science	2.9363	.46896	251
If I had students who did not like science, I am sure I could get students to like science	2.7729	.51403	251
My university has prepared me well to enthuse students about science	2.8088	.62872	251
I believe I can help students develop an enjoyment of science	3.0717	.40353	251
I am confident that my future students will love science	2.8884	.50150	251
I am responsible for maximizing my students' long term interest in science	3.2072	.61066	251

Communalities

	Initial	Extraction
It is important for teachers to increase students long-term interest	1.000	.415
I do not have strategies to enhance liking for science	1.000	.535
I know how to increase students' long-term interest in science	1.000	.437
It is not the teachers' responsibility to increase students' long-term interest in science	1.000	.611
I have the skills to increase students long-term interest in science	1.000	.651
My university has not prepared me with strategies to increase students' long-term interest in science	1.000	.711
I know how to motivate students' general interest in science	1.000	.535
If I had students who did not like science, I am sure I could get students to like science	1.000	.363
My university has prepared me well to enthuse students about science	1.000	.669
I believe I can help students develop an enjoyment of science	1.000	.547
I am confident that my future students will love science	1.000	.459
I am responsible for maximizing my students' long- term interest in science	1.000	.638

Extraction Method: Principal Component Analysis.

Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	
1	3.942	32.847	32.847	3.942	32.847	
2	1.512	12.601	45.449	1.512	12.601	
3	1.116	9.302	54.751	1.116	9.302	
4	.899	7.492	62.243			
5	.792	6.601	68.844			
6	.761	6.342	75.186			
7	.623	5.192	80.378			
8	.579	4.823	85.201			
9	.547	4.559	89.760			
10	.494	4.118	93.878			
11	.421	3.512	97.391			
12	.313	2.609	100.000			

Total Variance Explained

Component	Extraction Sums of Squared Loadings
	Cumulative %
1	32.847
2	45.449
3	54.751
4	
5	
6	
7	
8	
9	
10	
11	
12	

Extraction Method: Principal Component Analysis.

Component Matrix[a]

	Component		
	1	2	3
It is important for teachers to increase students long-term interest	.346	.532	-.109
I do not have strategies to enhance liking for science	.668	-.293	-.046
I know how to increase students' long-term interest in science	.649	-.018	.124
It is not the teachers' responsibility to increase students' long-term interest in science	.271	.708	.190
I have the skills to increase students long-term interest in science	.647	-.212	-.433
My university has not prepared me with strategies to increase students' long-term interest in science	.654	-.208	.489
I know how to motivate students' general interest in science	.641	-.089	-.341
If I had students who did not like science, I am sure I could get students to like science	.542	-.053	.258
My university has prepared me well to enthuse students about science	.658	-.215	.436
I believe I can help students develop an enjoyment of science	.550	.041	-.493
I am confident that my future students will love science	.669	.062	-.081
I am responsible for maximizing my students' long-term interest in science	.383	.700	.035

Extraction Method: Principal Component Analysis.[a]

a. 3 components extracted.