Investigating the Role of Situational Interest in Developing Individual Interest in Science and Self-Efficacy to Teach Science in Preservice Primary Teachers

by

Jeanette Maree Dixon

AM, TeachCert\textit{(Newcastle)}, BEd\textit{(UNE)}, MSc\textit{(Newcastle)}, Hon DEd\textit{(Newcastle)}

Thesis submitted in total fulfilment of the requirements of the

Degree of Doctor of Philosophy

School of Education

Faculty of Education and Arts

University of Newcastle, Australia

December, 2014

Principal Supervisor: Associate Professor David Palmer

Associate Supervisor: Dr Jennifer Archer
The thesis contains no material which has been accepted for the award of any other degree or diploma in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. I give consent to the final version of my thesis being made available worldwide when deposited in the University’s Digital Repository**, subject to the provisions of the Copyright Act 1968.

**Unless an Embargo has been approved for a determined period.

........................................................................................................................................
Acknowledgements

This thesis would not have been possible without the thoughtful, constant support and invaluable supervision from Associate Professor David Palmer and Dr Jennifer Archer. It has been an immense joy and privilege to have such knowledgeable, skilled, and enthusiastic academics provide advice and guidance for a project that defines my life. It takes special people to be so patient and caring in desiring the best for their student.

I would also like to extend my deepest gratitude to my many students who participated in the study and enabled me to build a report that may assist preservice primary teachers to look forward to teaching science in their future classroom.
Dedication

This thesis is dedicated to all members of my family who have been extremely understanding, supportive and very patient in having their wife, mother, grandmother, and daughter allocate a very large proportion of personal time to the preparation and the writing of this thesis. Their loving support and pride in my work has always encouraged me. I give special recognition to my husband who has been my constant strength, suffered any anxiety that I shared with him through my journey, and spent many lonely hours without me while I endeavoured to achieve the end result of my passion in science teacher education.
# Table of Contents

Acknowledgements ........................................................................................................ ii
List of Tables .................................................................................................................. ix
List of Figures ............................................................................................................... xi
Abstract ....................................................................................................................... xii

Chapter 1: Introduction ................................................................................................. 1
  1.1 Overview ................................................................................................................. 1
  1.2 Definitions of Terms ............................................................................................... 1
    1.2.1 Situational interest ......................................................................................... 1
    1.2.2 Individual interest ......................................................................................... 2
    1.2.3 Self-efficacy .................................................................................................. 2
  1.3 Theoretical Framework ......................................................................................... 3
    1.3.1 Situational interest ......................................................................................... 3
    1.3.2 Individual interest ......................................................................................... 4
    1.3.3 Self-efficacy .................................................................................................. 4
  1.4 Rationale ................................................................................................................ 5
  1.5 Research Questions of the Study ......................................................................... 6
  1.6 Study Design .......................................................................................................... 7
  1.7 Organisation of the Thesis .................................................................................... 8
  1.8 Significance of This Study .................................................................................... 10

Chapter 2: Problems with Primary Science in Australia ........................................ 12
  2.1 Introduction ......................................................................................................... 12
  2.2 Importance of Science in the Primary School ................................................... 12
  2.3 Historical Background of the Dilemma in Australian Primary Science .............. 14
  2.4 Problems of Primary Science Teaching in Australia .......................................... 15
    2.4.1 Problem: Too little time spent teaching science in the primary classroom ............................................................................. 15
    2.4.2 Problem: Quality of science teaching in the primary classroom is inadequate ........................................................................... 20
    2.4.3 Problem: Student achievement in primary science tests does not improve .................................................................................. 23
  2.5 The benefit of the Primary Connections Program in Australia .......................... 24
  2.6 Summary of Chapter 2 ........................................................................................ 25
6.3 Questionnaire 2: Reasons for Any Change in Individual Interest in Science

6.4 Individual Interviews
6.4.1 Changes in individual interest in science (Questions 1-6)
6.4.2 Causes of change in individual interest (Questions 7, 8, and 9)
6.4.3 Changes in self-efficacy for teaching science (Questions 10-14)
6.4.4 Causes of change in self-efficacy for teaching science

6.5 Summary of Chapter 6

Chapter 7: Discussion

7.1 Introduction
7.2 Research Question 1: Can situational interest be aroused during a science content unit for primary teacher education students, and if this does occur, how does this occur?
7.2.1 Was situational interest aroused?
7.2.2 Why was situational interest aroused?
7.2.3 Summary of the findings for Research Question 1

7.3 Research Question 2: Can strategies designed to generate situational interest enhance preservice primary teachers’ long-term individual interest in science?
7.3.1 Was individual interest in science increased?
7.3.2 What caused the increase in individual interest?
7.3.3 Summary of the findings for Research Question 2

7.4 Research Question 3: Can self-efficacy for teaching science be enhanced by use of the strategies designed to arouse situational interest?
7.4.1 Was self-efficacy to teach science improved?
7.4.2 What caused the increase in self-efficacy to teach science?
7.4.3 Summary of the findings for Research Question 3

7.5 Limitations

Chapter 8: Conclusions

8.1 Introduction
8.2 Conclusions for Research Question 1: Can situational interest be successfully aroused during a science content unit for primary teacher education students, and if so, how does this occur?
8.3 Conclusions for Research Question 2: Can strategies designed to generate situational interest enhance preservice primary teachers’ long-term individual interest in science?
8.4 Conclusion for Research Question 3: Can self-efficacy for teaching science be enhanced by use of the strategies designed to arouse situational interest?

8.5 Implications .................................................................................................................. 237

List of References ............................................................................................................. 240

Appendices ....................................................................................................................... 258

Appendix A  Information Statement for the Research Project ........................................ 259
Appendix B  Consent Form for the Research Project......................................................... 261
Appendix C  Survey 1: Interest in Science Topics ............................................................... 262
Appendix D  Survey 2: Personal Interest in Science ......................................................... 263
Appendix E  Survey 3 Preservice Primary Science Teaching Efficacy Belief Instrument .................................................................................................................. 264
Appendix F  Questionnaire 1 What interested you in this tutorial? ............................... 265
Appendix G  Questionnaire 2 Did you change your interest in science? ....................... 266
Appendix H  Survey 4 Level of Interest Generated by Teaching Strategies During Tutorials and Lectures ......................................................................................................... 267
Appendix I  Examples of teaching techniques, resources and worksheets used in this study .................................................................................................................. 268
Appendix J  Principal Components Factor Analysis for Survey 2 ............................... 281
List of Tables

<table>
<thead>
<tr>
<th>Table</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 1</td>
<td>Comparison of Problems with Teaching Science for Preservice and Inservice Primary Teachers</td>
<td>26</td>
</tr>
<tr>
<td>Table 2</td>
<td>Gender and Age of Participants</td>
<td>78</td>
</tr>
<tr>
<td>Table 3</td>
<td>Schedule of Weekly Topics in the Science Content Unit</td>
<td>79</td>
</tr>
<tr>
<td>Table 4</td>
<td>Techniques used in Lectures and Tutorials</td>
<td>89</td>
</tr>
<tr>
<td>Table 5</td>
<td>Topics Used in Survey 1</td>
<td>92</td>
</tr>
<tr>
<td>Table 6</td>
<td>Schedule for Collecting Quantitative and Qualitative Data</td>
<td>103</td>
</tr>
<tr>
<td>Table 7</td>
<td>Participants in the Pretest ($N = 313$)</td>
<td>108</td>
</tr>
<tr>
<td>Table 8</td>
<td>Participants in the Immediate Posttest ($n = 199$)</td>
<td>109</td>
</tr>
<tr>
<td>Table 9</td>
<td>Participants in the Delayed Posttest ($n = 136$)</td>
<td>110</td>
</tr>
<tr>
<td>Table 10</td>
<td>Participants Responding to All Surveys on All Three Occasions ($n = 104$)</td>
<td>111</td>
</tr>
<tr>
<td>Table 11</td>
<td>Number of Administrations of Surveys</td>
<td>112</td>
</tr>
<tr>
<td>Table 12</td>
<td>Interest in Science Topics at the Pretest Administration ($N = 313$)</td>
<td>113</td>
</tr>
<tr>
<td>Table 13</td>
<td>Interest in Science Topics at the Immediate Posttest Administration ($n = 199$)</td>
<td>113</td>
</tr>
<tr>
<td>Table 14</td>
<td>Interest in Science Topics at the Delayed Posttest Administration ($n = 136$)</td>
<td>114</td>
</tr>
<tr>
<td>Table 15</td>
<td>Comparison of Interest in Science Topics Lists A and B</td>
<td>115</td>
</tr>
<tr>
<td>Table 16</td>
<td>Means and Standard Deviations for Interest in Science Topics List A and Interest in Science Topics List B across the Three Times of Administration ($n = 106$)</td>
<td>117</td>
</tr>
<tr>
<td>Table 17</td>
<td>Pretest Results for Individual Interest in Science ($N = 313$)</td>
<td>120</td>
</tr>
<tr>
<td>Table 18</td>
<td>Comparing Interest in Science Responses for the 105 Students and the Other Students Who Completed the Survey</td>
<td>122</td>
</tr>
<tr>
<td>Table 19</td>
<td>Descriptive Statistics for the PSTE results (13 items)</td>
<td>124</td>
</tr>
<tr>
<td>Table 20</td>
<td>Post Hoc Pairwise Comparisons of the PSTE Subscale for Participants ($n = 104$)</td>
<td>125</td>
</tr>
<tr>
<td>Table 21</td>
<td>Descriptive Statistics for the STOE Results (8 items) ($n = 104$)</td>
<td>126</td>
</tr>
<tr>
<td>Table 22</td>
<td>Post Hoc Pairwise Comparisons of the STOE Subscale for Participants ($n = 104$)</td>
<td>126</td>
</tr>
</tbody>
</table>
Table 23  Descriptive Statistics for Interest Aroused by Teaching Techniques \((n = 243)\)……………………………………………………………

Table 24  Correlations between Individual Interest in Science and Personal Science Teaching Efficacy at Times 1, 2, and 3…………………..

Table 25  Sources of Situational Interest in Week 4…………………………………….

Table 26  Sources of Situational Interest in Week 7……………………………………

Table 27  Sources of Situational Interest in Week 9……………………………………

Table 28  Percentages of Responses for Different Sources of Situational Interest ……………………………………………………………..

Table 29  Results for Item 1 of Questionnaire 2……………………………………

Table 30  Causes of Increase in Individual Interest……………………………………

Table 31  Details of Students Interviewed………………………………………………

Table 32  Sources of Situational Interest Reported by Each Student \((n = 24)\). 184

Table 33  Change in Confidence from Before the Science Unit to After the Science Unit……………………………………………................

Table 34  Causes of Change in Self-efficacy to Teach Science for Each Participant \((n = 25)\) ………………………………………………………..
# List of Figures

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Figure 1</td>
<td>Comparison of Means for the Three Administrations of Survey 1 for All Participants</td>
<td>114</td>
</tr>
<tr>
<td>Figure 2</td>
<td>Week 4 “Energy” tutorial: Frequency of responses for each teaching technique</td>
<td>145</td>
</tr>
<tr>
<td>Figure 3</td>
<td>Week 7 “The Human Body” tutorial: Frequency of responses for each teaching technique</td>
<td>151</td>
</tr>
<tr>
<td>Figure 4</td>
<td>Week 9 “Natural Selection” tutorial: Frequency of responses for each teaching technique</td>
<td>157</td>
</tr>
</tbody>
</table>
Abstract

The study is designed to investigate the relationship between situational interest and individual interest, and between situational interest and self-efficacy for teaching science. Situational interest is a temporary kind of interest that can be spontaneously stimulated in a person by something in the environment. It has been argued that exposure to regular experiences of situational interest can promote individual interest, which is a long-lasting personal preference for a content area. This study also investigates the nature of a relationship between situational interest and self-efficacy, that is, a belief in one’s capabilities to perform a task successfully. These are important matters for primary teacher education students because it is unlikely that they will teach science well if they have no individual interest in it and low self-efficacy to teach it. The major research questions of this study were as follows:

1. Can situational interest be successfully aroused during a science content unit for primary teacher education students, and if so, how does this occur?
2. Can strategies designed to generate situational interest enhance preservice primary teachers’ long-term individual interest in science?
3. Can self-efficacy for teaching science be enhanced by use of the same strategies designed to arouse situational interest?

The study was conducted using a preexperimental design comprising a pretest, immediate posttest, delayed posttest, and mixed method data collection. The participants undertaking the pretest were 313 primary teacher education students most of whom were in their first year of university study. However, there was a
reduction in number of participants by the end of the science unit to 199 for the immediate posttest data collection. By the time of the delayed posttest ten months after the completion of the science unit, the participant number had dropped to 136 for data collection.

The study began in a one-semester science content unit that was designed to enhance students’ knowledge of science concepts. This unit was written and taught by the researcher who made use of techniques designed to stimulate situational interest in science. These techniques included hands-on activities, science magic, toys, demonstrations, analogies, anecdotes, and fun facts.

Quantitative and qualitative data were collected. These included two self-developed surveys to measure individual interest, one survey to measure the level of situational interest generated by the different kinds of teaching techniques used during the unit, Enochs and Riggs’ (1990) STEBI-B instrument to measure self-efficacy, open ended questionnaires administered during the science unit, and individual interviews conducted at the end of the semester. Results showed that individual interest in science and self-efficacy to teach science increased substantially from pretest to immediate posttest. Individual interest in science dropped somewhat from immediate posttest to delayed posttest but self-efficacy to teach science remained stable from immediate posttest to delayed posttest. Participants reported high levels of situational interest throughout the unit. Situational interest was linked to specific teaching techniques, relevance to teaching primary science, the experience of successful learning, teacher qualities, novelty, physical activity, and social interaction. The factors that aroused situational interest
in science also enhanced self-efficacy to teach science. Both situational interest in science and self-efficacy to teach science appear to enhance individual interest in science.

This study provides evidence that the factors that generate situational interest in science can also enhance students’ long-term interest in science and their self-efficacy to teach science.
Chapter 1
Introduction

1.1 Overview

Researchers have proposed that sustained situational interest can develop into long-lasting individual interest. The main purpose of this study was to investigate whether it was possible to enhance individual interest for science in preservice primary teachers by the sustained use of varied strategies that were designed to stimulate situational interest. After defining terms (Section 1.2), this chapter will provide the theoretical background for the study (Section 1.3). The rationale of the study is described in Section 1.4. The research questions of the study are presented in Section 1.5 followed by the study design (Section 1.6). The overview of the thesis organisation is found in Section 1.7. The chapter concludes with a statement about the significance of this study (Section 1.8).

1.2 Definition of Terms

1.2.1 Situational interest

Hidi (1990) defined situational interest as a kind of interest that “tends to be evoked more suddenly by something in the environment and may have only a short term effect, marginally influencing an individual’s knowledge and values” (p. 551). Situational interest can arouse and focus student attention when triggered by factors in the immediate learning environment, but it is transient (Hidi, 1990; Hidi & Anderson, 1992; Hidi & Baird, 1986). For example, a surprising science
demonstration may trigger a fleeting interest amongst all students, even those who are not particularly interested in science.

### 1.2.2 Individual interest

Hidi and Harackiewicz (2000) defined individual interest as a “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). Individual interest tends to be long-lasting and develops more slowly as a result of life experiences. Hence, long-lasting individual interest is different from transient situational interest. Individual interest varies from person to person. Typically it may be directed towards an activity such as reading, playing or watching a sport, listening to music, playing an instrument, or liking a particular subject such as astronomy or mathematics. For example, a student may come to science lessons with an already established individual interest in biology, but not necessarily in other branches of science.

### 1.2.3 Self-efficacy

Bandura (1997) defined self-efficacy as “the belief in one’s capabilities to organize and execute the courses of action required to produce given attainments” (Bandura, 1997, p. 3). Often viewed interchangeably with self-confidence (Appleton & Kindt, 2002; Palmer, 2006b; Watters & Ginns, 2000), self-efficacy is predictive of behaviour and persistence with a task (Bandura, 1986). For example, a student with high self-efficacy for a particular task, compared with a student with low self-efficacy, would usually participate more keenly in the task and would be confident
that she or he has the ability to perform that the task successfully. The influence of high and low self-efficacy would be especially noticeable if the task is a difficult one (Bandura, 1986).

1.3 Theoretical Framework

The current study uses the theoretical framework of interest, in particular, the relationship between situational interest and individual interest. In addition, self-efficacy theory and interest theory form the basis for the examination of the relationship between situational interest and self-efficacy to teach science.

1.3.1 Situational interest

Situational interest plays an important role in learning (Bergin, 1999; Hidi, 1990; Hidi & Baird, 1986; Schraw, Flowerday, & Lehman, 2001; Wade, 2001). Although transitory, situational interest aroused in a student can focus the student’s attention, promote task engagement, assist comprehension, and aid recall of the information (Mitchell, 1993; Schiefele, Krapp, & Winteler, 1992; Wade, 2001; Wade, Schraw, Buxton, & Hayes, 1993).

Hidi and Anderson (1992) have argued that teachers should expose all students to experiences that generate situational interest rather than attempting to address the varied prior interests of students. No one topic in the school curriculum would be of interest to all students (Mitchell, 1993; Schraw et al., 2001). The differing interests of students may not be easily adapted to classroom learning. Hence, Hidi and Harackiewicz (2000) argue that classroom environments should arouse situational interest to assist students to learn, particularly when the topic originally holds little
interest for many of them.

1.3.2 Individual interest

Individual interest assists learning because it holds a person’s attention and promotes effort to understand a topic or activity (Krapp, Hidi, & Renninger, 1992). Individual interest encourages students to recall information and enhances their desire to extend their learning (Hidi & Harackiewicz, 2000). Studies have shown a positive relationship between individual interest and academic achievement (Hulleman & Harackiewicz, 2009; Krapp et al., 1992; O’Keefe & Linnenbrink-Garcia, 2014; Renninger, Ewen, & Lasher, 2002; Schiefele et al., 1992). Academic achievement is a consequence of students wanting to learn, being able to recall prior information, being able to process new information, and being willing to ask questions (Ainley, Hidi, & Berndorff, 2002; Hidi, 1990; Krapp et al., 1992; Pintrich & Schunk, 1996; Renninger, 2000; Renninger & Hidi, 2002; Schiefele et al., 1992).

1.3.3 Self-efficacy

Tschannen-Moran, Woolfolk Hoy, and Hoy (1998) have argued that “greater efficacy leads to greater effort and persistence which leads to better performance” (p. 233). In other words, the level of confidence people bring to specific tasks plays an important role in their success or failure on those tasks. Students with high self-efficacy will try harder because they believe they are capable of performing the task. High self-efficacy not only can enhance students’ learning but also can enhance teachers’ teaching. The higher the teachers’ self-efficacy for teaching, the more confidence they have in their ability to help students to learn (Woolfolk Hoy, 2003).
These teachers are generally willing to trial new strategies to enhance students’ learning (Woolfolk Hoy, 2003). A teacher’s self-efficacy to teach may promote students’ self-efficacy to learn because students pick up cues from the teacher that she expects that they will be able to learn (Ross, 1992).

1.4 Rationale

Situational interest can arouse and focus attention. Although it is spontaneous and temporary, it has been argued that repeated exposure to experiences of situational interest in an area can promote individual interest in the same area (Hidi & Anderson, 1992; Hidi & Renninger, 2006; Krapp, 2002). A small number of studies have investigated the relationship between situational interest and individual interest in academic domains (Ainley, Hidi, et al., 2002). These studies have generally supported the idea that sustained situational interest is fundamental to building students’ individual interest.

For example, Mitchell and Gilson (1997) conducted a study with fifth grade students and university mathematics students. They reported a positive connection between classrooms rated high in situational interest and students’ individual interest in mathematics. Mitchell (1997) conducted a study to investigate if high school and university students experiencing high situational interest in statistics increased their individual interest for statistics. Mitchell found that high situational interest significantly increased individual interest especially for students who had low pretest individual interest scores. Harackiewicz, Barron, Tauer, Carter, and Elliot (2000) conducted a study using students in an introductory university psychology course.
They demonstrated that students’ continued enrolment in psychology in subsequent years was a result of high situational interest and continued or increased individual interest. Del Favero, Boscolo, Vidotto, and Vincentini (2007) researched interest in history using discussion and individual problem solving as situational interest triggers. They found that students reported significant gains in individual interest as a result of the generation of situational interest.

Relevance to a future career may be the link between situational interest in science and self-efficacy to teach science. Preservice primary teachers are acutely aware that, to be effective teachers, they must understand science and they must know how to teach science. For example, Palmer (2001) found that modelling, by the instructor, of interesting teaching techniques to explain science concepts enhanced the self-efficacy to teach science of trainee primary teachers. Examples of teaching techniques used in Palmer’s study were hands-on activities, science trivia, anecdotes, and demonstrations. These techniques are similar to techniques designed to enhance situational interest in the present study.

These studies provide support for a relationship between situational interest and individual interest and between situational interest and self-efficacy.

1.5 Research Questions of the Study

There is a large body of research across Australia revealing problems in the teaching of primary science (Dekkers & De Laeter, 2001; Goodrum, Hackling, & Rennie, 2001). Preservice primary school teachers struggle with science and have low self-efficacy beliefs about teaching it (Bleicher, 2007; Bursal, 2012; Jarrett,

They have described feelings of inadequacy to teach science, feelings that will affect their ability to present science effectively in their future classrooms (Appleton, 2002; Ginns & Watters, 1999; Skamp, 1991; Tytler, Osborne, Williams, Tyler, & Cripps Clark, 2008; Watters & Ginns, 2000).

It has been proposed that situational interest can enhance an individual interest for a task or domain (Hidi & Renninger, 2006). This study has been designed to investigate whether sustained use of strategies developed to arouse situational interest during a university science content unit can increase preservice primary teachers’ individual interest in science. In addition, the study investigates whether the same sustained strategies designed to stimulate situational interest can increase preservice primary teachers’ self-efficacy to teach science.

The major research questions of this study are presented below:

1. Can situational interest be successfully aroused during a science content unit for primary teacher education students, and if so, how does this occur?
2. Can strategies designed to generate situational interest enhance preservice primary teachers’ long-term individual interest in science?
3. Can self-efficacy for teaching science be enhanced by use of the strategies designed to arouse situational interest?

1.6 Study Design

This study used a preexperimental research design with mixed methods data collection (McMillan & Schumacher, 2010). The “treatment” involved the use of
regular and varied strategies designed to stimulate situational interest during the lectures and tutorials of a science content unit.

The study used both quantitative and qualitative data collection as a means of enhancing validity and reliability of the findings (Creswell, 2003). Quantitative data were collected from four surveys. Three were administered in the following manner: a pretest before treatment began; a posttest immediately at the completion of the treatment; and a delayed posttest ten months after the treatment. A fourth survey collected data once only at the completion of the unit. Qualitative data were gathered from open-ended questionnaires and individual interviews.

1.7 Organisation of the Thesis

Chapter 1 has introduced the focus of the study with its relevant terminology, rationale for the research, the research questions, study design, organisation of the thesis, and significance of the research. The following sections briefly outline the content of Chapter 2 through to Chapter 8.

Chapter 2 presents the importance of science in the primary school curriculum in Australia. The concerns about a lack of high quality primary science education are detailed.

Chapter 3 provides a literature review of situational interest, individual interest, topic interest, and self-efficacy. Studies involving situational interest in various domains are presented, and sources of situational interest and its importance to education are also included. Similarly, studies of individual interest are included. The construct of topic interest is also described due to its close relationship with
individual interest. Research studies examining the relationship between situational interest and individual interest are examined. The role of self-efficacy is explained, especially in relation to preservice primary teachers. Research examining links between interest and self-efficacy complete the chapter.

Chapter 4 introduces the design used in the study. There is a discussion of how the research design enhances the validity and reliability of the data gathered. The participants of the study are described in terms of number, age, and sex. This is followed by the description of how the treatment was incorporated into the science unit. The activities designed to generate situational interest are described. The quantitative and qualitative data gathered for the study are described along with data analysis techniques.

Chapter 5 presents the results of the quantitative data. Data were collected from surveys assessing individual interest for science and self-efficacy to teach science. These surveys were completed by participants at the beginning of the unit (pretest), at the end of the unit (immediate posttest), and ten months after the science unit was completed (delayed posttest). The delayed posttest was incorporated into the study to look for evidence of long-term individual interest. Survey 1 measured interest in a range of science topics taught and not-taught in the science unit. Survey 2 measured individual interest in science related activities. Survey 3 measured self-efficacy to teach science. Survey 4, completed only once at the end of the science unit, measured students’ reported situational interest generated by the strategies used in the lectures and tutorials.

Chapter 6 presents the analysis of the multiple sources of qualitative data.
There were data from open-ended questionnaires completed during the unit (Questionnaire 1) and at the end of the unit (Questionnaire 2). There were individual interviews with students. All qualitative data were transcribed, reviewed, and coded for themes. Samples of typical comments offered by participants in interviews and open-ended questionnaires have been included in the chapter.

Chapter 7 presents a discussion of the findings of the study. This is followed by a discussion of the limitations of the study.

Chapter 8 concludes the study. What are the implications for university staff preparing preservice primary teachers to teach science? What are the recommendations for future research?

1.8 Significance of the Study

Previous studies have focused on the effect of situational interest on the development of individual interest. This study has been designed to add to existing knowledge in the following ways.

First, to date no studies have been conducted during a university science content unit to investigate if situational interest can be aroused by use of a series of teaching strategies.

Second, to date no studies have investigated the possibility of situational interest enhancing individual interest in science in preservice primary teachers. If such a link between situational interest and individual interest can be demonstrated, this finding can inform the preparation of preservice primary teachers.

Third, to date no studies have investigated a link between sustained situational
interest during a university science content unit and the self-efficacy of preservice primary teachers to teach science. If such a link can be demonstrated, this finding also can inform the preparation of preservice primary teachers.
Chapter 2

Problems with Primary Science in Australia

2.1 Introduction

There is a large body of evidence revealing a problem related to the teaching of science in the primary classroom in Australia (Dekkers & De Laeter, 2001; Goodrum et al., 2001). Rennie, Hackling, and Goodrum (2001) argued in a national research report that “in primary schools, the problem is not so much what is taught but rather whether science is taught at all” (Rennie et al., 2001, p. 486).

This chapter begins by presenting the importance of science in the primary school curriculum (Section 2.2). The historical background of the dilemma in primary science education in Australia is described in Section 2.3. Research findings about problems with primary science are presented in Section 2.4. This information is followed by a summary of the chapter (Section 2.5).

2.2 Importance of Science in the Primary School

Science is a compulsory learning area of the Australian school curriculum from early childhood years to the completion of studies in the junior high school at Grade Ten. A report from the Ministerial Council on Education, Employment, Training and Youth Affairs (2006) stated “the purpose of science in primary schools is to provide opportunities for students to know science as a body of knowledge, as a way to know the world and as a human endeavour, and to develop students’ scientific literacy” (p. 2).
Goodrum et al. (2001) have advocated that learning science must be of benefit to people so that they can have some degree of science understanding during their everyday lives. Many concerns in our communities relate to science issues, for example, nutrition, health, pollution, conservation, and global warming. Science education aims to allow all Australian students to become scientifically literate in preparation for understanding themselves and their surroundings. Hence, science education should allow students to become citizens who are active decision-makers capable of applying science knowledge to deal with personal needs and society’s problems and requirements (Eady, 2008). Century, Rudnick, and Freeman (2008) advised that the teaching and learning of science knowledge is necessary to effectively engage in this 21st century must begin as early as preschool. To ensure quality science education in the primary school, inspiring teaching of science should be evident in every primary classroom, with teachers confident in their science knowledge and able to engage their students in exciting learning experiences.

In 2003, the Department of Education, Science and Training (DEST) stated that science education in Australia needed to be improved. The report argued that “the relative inattention to science teaching and learning in primary schools is inconsistent with aspirations for a scientifically literate society and excellence in Australian scientific achievement” (p. 11). The DEST research report was designed to promote more effective teaching of science in the primary classroom, arguing that enthused students of science in their younger years will go on to become keen students of science during high school years and beyond (DEST, 2003).

The 2006 Programme for International Student Assessment (PISA) indicated
a large proportion of students about to complete junior high school had very little or no interest in wanting to study physics, chemistry, or biology (Thomson & De Bortoli, 2008). Australia, which had 356 schools and 14,170 students participating in the 2006 PISA survey, was ranked 54th of 57 participating countries with respect to students’ general interest in learning science (Thomson & De Bortoli, 2008). These authors also reported that Australia was ranked 45th for students’ enjoyment of science. In response to these statistics, Tytler (2007) argues that students must become interested in science as early as possible in their young years of primary school life.

2.3 Historical Background of the Dilemma in Australian Primary Science

National awareness of inadequate teaching of science by inservice teachers in the primary classroom was flagged by the 1989 National Discipline Review of Teacher Education in Mathematics and Science reported by Speedy, Annice, Fensham, and West (1989). This report indicated that most preservice primary teachers possessed negative attitudes to science content, science teaching, and science learning. More importantly, the review drew attention to problems with preparing primary teachers in universities. This had resulted in a lack of science knowledge that, in effect, reduced teaching confidence and increased negativity of trainee teachers towards science (Speedy et al., 1989). Similarly, Dekkers and De Laeter (2001) noted that early science education provided in primary schools before 1990 was limited, disorganised, and infrequently taught. Hackling (2006) later stated, “The teaching of science in primary schools has been a cause for concern for some
time and despite the recognition of science as a priority area of learning, science teaching has a low status in the primary curriculum” (Hackling, 2006, p. 4).

2.4 Problems of Primary Science Teaching in Australia

Evidence from recent national and international studies reveals problems associated with the teaching of science in Australian primary schools. First, teachers spend too little time providing science education. Second, the quality of the science teaching is regarded as inadequate. Third, student achievement in international primary science tests is inadequate. The problems have various causes that have arguably hindered inservice primary teachers providing quality science lessons, weakened science teaching preparation of preservice primary teachers, and reduced student learning of science.

2.4.1 Problem: Too little time spent teaching science in the primary classroom

1. Evidence from national research

In their report, Goodrum et al. (2001) claimed that Australian primary students, on average, receive less than one hour of science per week. However, Goodrum et al. (2001) point out that this time is probably in excess of the actual time spent teaching science. Also, in New South Wales, teachers find it difficult to distinguish the science outcomes of the syllabus from the technology outcomes of the same syllabus (Goodrum et al., 2001). Their report, using data from 290 schools, concluded that science teaching and learning in primary Australian schools was a cause for concern.

Angus, Olney, Ainley, Caldwell, Burke, Selleck, and Spinks (2004) reported...
that the allocation of science teaching time in the Australian primary classroom was an average of only 2.7% of the teaching week, even though science is a compulsory area of the curriculum. Angus et al. (2004) asserted that primary teachers spend less time on science than all other subjects except for Language Other Than English (LOTE).

2. Evidence from international studies

The Trends in International Mathematics and Science Study (TIMSS) is the longest running survey of international science education in Year 4 and Year 8. The aim of TIMSS is to assist countries evaluate the progress of the teaching of science and mathematics over time, to complement national studies, and to identify the strengths and weaknesses of education systems (Riley & Torrance, 2003). This project has been conducted at four year intervals since 1995. In the report for the 2007 survey compiled by Martin, Mullis, and Foy (2008), over 4000 students participated from 229 Australian primary schools. The 2007 TIMSS report revealed that the average time spent by surveyed Australian teachers in teaching science to Year 4 students was only 5% of their overall teaching time. This was the fourth lowest of all countries participating in TIMSS, and below the international average of 7% (Thomson, Wernet, Underwood, & Nicholas, 2008). Thomson et al. (2008) also noted that only 46% of Australian Year 4 teachers surveyed for TIMSS said they were well prepared for teaching the science in the syllabus.

This trend has not changed since Australia’s first involvement in the TIMSS study in 1995. The international average for 2007 was 54% of teachers considering themselves well prepared to teach science. In the 2007 TIMSS report, the Year 4
performance in some science items revealed a lack of quality in students’ knowledge. Most students were not able to answer science questions that required deeper comprehension (Thomson & Buckley, 2009).

In the 2011 TIMSS survey, Australian primary school principals reported that 1008 hours were devoted to teaching the school curriculum during Year 4, but science teaching time was 65 hours. This was “far less time than was reported for either reading or mathematics” (Thomson, Hillman, Wernert, Schmid, Buckley, & Munene, 2012, p. 129). The 2011 TIMSS report also showed that only 43% of Australian teachers expressed confidence in teaching science (Thomson et al., 2012). The international average was 59%.


To compound the concern about inadequate teaching time of science in Australian primary schools, the Organisation for Economic Co-operation and Development or OECD (2009) had indicated in its international research report “Education at a Glance” that Australia was ranked last in 28 OECD countries for the percentage total instruction time allocated to teaching science to primary age 9-11 year old students. Teaching time for science was a low 3% of a total of 955 hours of the year in public schools, an average of approximately 43 minutes each week for 40 weeks in the school year (OECD, 2009).

Thus, evidence for too little time spent teaching science has emerged from national and international research. Thomson and De Bortoli (2008) suggested that educational policy in Australia should seriously consider that “there is a case for finding ways to increase science expertise in schools for increasing the small amount
of time given to the teaching of science in primary schools” (p. 209).

Cause: Many primary teachers reluctant to teach science

Researchers have described primary teachers, both practising and preservice, as possessing feelings of anxiety and inadequacy which negatively affect their belief that they can successfully teach science (Appleton, 2002; Ginns & Watters, 1999; Palmer, 2006b; Skamp, 1991; Watters & Ginns, 2000). Science education is threatening and onerous to many primary classroom teachers as well as preservice teachers. This situation frequently results in avoidance of science (Rice & Roychoudhury, 2003).

Dekkers and De Laeter (2001) argue that primary teachers’ reluctance to teach science is evident across the range of teaching experience with both recent graduates and mid to late career primary teachers. Many teachers have sidestepped teaching this mandatory part of the curriculum, or have given it only superficial treatment (Goodrum et al., 2001). To exacerbate the problem, primary teachers have preferred to abandon science lessons in preference to other subjects of the classroom timetable and when students attend events such as swimming carnivals or school concerts (Tytler et al., 2008). Tytler et al. (2008) explained that this lack of science lessons is mainly due to primary teachers’ lack of confidence to teach science.

Cause: Teachers and preservice primary teachers dislike science because of negative feelings from prior school experiences

Resistance to teaching the science component of the primary curriculum has been seriously influenced by a dislike of science held by many practising and preservice primary teachers (De Laat & Watters, 1995; Palmer, 2006b; Skamp &
Mueller, 2001; Watters & Ginns, 2000). It has been argued that primary teachers’ aversion to science possibly was initiated or aggravated by unfortunate previous experiences with science in high school (De Laat & Watters, 1995; Mulholland & Wallace, 1996; Watters & Ginns, 2000). Hawkins (1990) also asserted that primary teachers’ lack of interest in teaching science was often due to the way that they were taught at school. Their dislike of science could be passed on to their future students. This negativity to science was often intensified during primary teacher training by students’ misunderstanding of science. Many students thought that they would be required to experience the same depth of understanding during their undergraduate studies as other university students specialising in science (Mulholland & Wallace, 2002).

**Cause: Teachers work with an overloaded curriculum with a priority on other subjects**

A report about Australian primary schools claimed that science continues to suffer from schools’ high accountability to mathematics and literacy in an “already over-crowded teaching program invaded by ever increasing expectations” (Australian Academy of Technological Sciences and Engineering, 2002, p. 14). Rennie et al. (2001) revealed that primary teachers felt that their curriculum was too crowded and, as a result, science was considered of less importance than other subjects. Rennie et al. (2001) argue that “if all primary students are to experience suitable science learning, schools need to recognise and reinforce the importance of science. Each primary school needs to ensure that sufficient time is allocated to science in all classrooms.” (p. 492).
2.4.2 Problem: Quality of science teaching in the primary classroom is inadequate

With respect to science teaching, Hudson, Skamp, and Brooks (2005) acknowledge that “effective teaching is at the heart of effective learning” (p. 5). Goodrum et al. (2001) noted that more science is being taught in primary schools in comparison to earlier decades in Australia. However, Rennie and Goodrum (2007) pointed out that many teachers still need to change their current practice so that the quality of science teaching improves.

Cause: Many primary teachers possess low confidence to teach science

Tschannen-Moran et al. (1998) describe teachers’ self-efficacy as their belief in achieving a teaching responsibility. However, it is evident many preservice and inservice primary teachers have low confidence for teaching science. This has impacted negatively on the inclusion of science education in classrooms (Ginns & Watters, 1999; Palmer, 2006a). Dekkers and De Laeter (2001) found that low confidence to teach science was evident in experienced primary teachers as well as new teachers. With respect to long-term, experienced primary teachers, the Australian Science, Technology and Engineering Council (1997) stated that many teachers had limited or no science preparation during their tertiary teacher studies. Additionally, many primary teachers did not have any science after Year 10 in secondary schools.

Cause: Primary teachers and preservice primary teachers have limited science knowledge

Goodrum et al. (2001) have reported that the primary teachers lack theoretical
knowledge of science. A consequence of inadequate science content knowledge is the preference to teach as little science as possible (Akerson, 2005; Appleton, 2003). Ginns and Watters (1999) also described preservice primary teachers generally having an unacceptable knowledge of science.

**Cause: Many teachers have limited teaching strategies for primary science, exacerbated by little professional development**

Primary teachers’ limited science knowledge and teaching skills was further exacerbated by insufficient professional development (Goodrum et al., 2001). Rennie and Goodrum (2007) argued that the provision of quality professional learning was essential for all teachers, in remote and regional locations as well as city locations. This professional assistance needs to be sustained over a period of time, not a one-off (Rennie & Goodrum, 2007).

**Cause: Teachers do not have enough time to prepare science lessons**

Of the 209 primary teachers interviewed by Rennie et al. (2001), more than half claimed they had to make preparations for their science lessons at home or grab a load of relevant science books from the library. This was due to inadequate time to organise a science lesson.

**Cause: Teachers need resources, equipment, and a larger school science budget to enable the purchase of essential materials for science**

Goodrum et al. (2001) surveyed teachers about available equipment and resources in their schools that could assist them to teach science. Their data revealed that 29% of teachers rated this situation as poor. Only 22% of teachers described
their schools as well-equipped. With respect to school resources, relevant equipment, and school budget required for the quality teaching of science, the primary teachers reported the following limiting factors: lack of resources (39%); too little equipment (19%); not enough science curriculum materials (9%); 7% said a larger school budget for science was essential. This action was proposed by Goodrum et al. (2001):

It is suggested each educational jurisdiction prepares a strategic plan to be implemented over three years to provide appropriate resources to all primary schools to support the teaching of science that promotes the development of scientific literacy. The resources may include equipment, materials, curriculum resources and technical support. There may be value in educational jurisdictions discussing with the Commonwealth for how such science teaching resource plans could be funded. (p. 177)


**Cause: Preservice teachers lack mentoring during preservice primary teachers’ practica**

Lawrance and Palmer (2003) found that in some schools it was difficult to find high quality role models for science teaching during the student practicum. Jarvis, McKeon, Coates, and Vause (2001) also argued that cooperating teachers were not confident in supporting preservice primary teachers in science during practica. To intensify the problem, Tytler et al. (2008) found that tertiary teacher educators report
that their primary teacher education students have not observed science teaching during their practicum, nor have they been supported to teach science.

2.4.3 Problem: Student achievement in primary science tests does not improve

Cause: Lack of formal science assessment in the Australian primary classrooms may affect student progress in science

Rennie et al. (2001) found in national student surveys \(N = 1221\) and teacher surveys \(N = 209\) that formal tests for evaluating the progress of students in science were rarely undertaken in the Australian primary classroom. Teachers preferred more informal strategies, such as observation, check lists, work samples, projects and oral presentations. Reporting in science was often based on a simple, satisfactory, or unsatisfactory category or the ticking of boxes with an appropriate comment. It also appeared that too many teachers did not report the outcomes of their students’ science progress to parents (Rennie et al., 2001). This lack of formal assessment in primary science means that students can be unaware of their actual progress in learning science. Rennie et al. (2001) argued that “reports should provide information that is meaningful and useful to parents, report achievement against defined standards and indicate how the child can be assisted to make progress towards defined learning outcomes”.

The review of the 2007 Trends in International Mathematics and Science Study (TIMSS) results by Thomson et al. (2008) expressed concern about the static TIMSS science results of Australian fourth grade students. Over the years of testing, other students internationally are continuing to improve and to do better than Australian
students. This situation further deteriorated as revealed in the 2011 TIMSS science results (Thomson et al., 2012). Over 6000 Year 4 students in 280 schools in Australia participated in TIMSS 2011. Australia’s average scale score of 516 for science achievement of Year 4 students was significantly lower than 527 in 2007 and less than the score of 520 achieved in 1995. Overall, the achievement levels of Australian Year 4 students in 1995 (520), 2003 (521), 2007(527), and 2011(516) TIMSS science assessments have remained static (Thomson et al., 2012). Australia’s position of Year 4 students in 59 participating countries was significantly lower than 18 other countries.

2.5 The Benefit of the Primary Connections Program in Australia

To address the concerns of primary science teaching in Australia, the Australian Academy of Science initiated the national Primary Connections program trialled first in 2005. “Primary Connections is a teacher professional learning program supported with curriculum resources that aims to enhance learning outcomes in science and the literacy of science by supporting both inservice and preservice primary teachers to teach science effectively” (Hackling, Peers, & Prain, 2007. p. 12).

From the second stage trial study with 106 trial teachers in 56 schools across Australia, Hackling and Prain (2005) reported that the Primary Connections program was successful. Their summary of the survey data from the participating teachers found an 83% increase in primary teacher self-efficacy with a 98% improvement in teaching science. The authors further claimed that the improvement in self-efficacy
for teaching science due to the use of the Primary Connection resources had increased both teaching time for science in the primary classroom and students’ achievement in science. These results were strengthened by Skamp’s (2012) study of the effectiveness of the Primary Connections science units collected data from teachers who trialled Primary Connections units between 2005 and 2012. Over 200 sets of teacher responses provided evidence that teachers’ confidence and competence to teach science had also been enhanced by their students’ interest, enjoyment, and learning of the science.

2.6 Summary of Chapter 2

This chapter highlighted problems in Australian primary science education. The teaching of science is often neglected. Science teaching and learning in primary schools are important, especially for the development of scientific literacy and the ability to apply science knowledge in one’s life (Eady, 2008).

The research evidence shows three main problems in primary science education: teachers spend too little time teaching science (Angus et al., 2004; Goodrum et al., 2001; Thomson et al., 2008); the quality of science teaching is poor; and students’ results in international science studies indicate no improvement from 1995 to 2011. The comparison of causes of the problems with teaching primary science for preservice and inservice primary teachers is summarised in Table 1.
Table 1

Comparison of Problems with Teaching Science for Preservice and Inservice Primary Teachers

<table>
<thead>
<tr>
<th>Problems with teaching science for preservice and inservice primary teachers</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Reluctance to teach science or avoid teaching science in the classroom</td>
<td>Inservice</td>
</tr>
<tr>
<td>Dislike of science due to negative feelings from prior experiences</td>
<td>Pre &amp; inservice</td>
</tr>
<tr>
<td>An overloaded curriculum with a priority for other subjects</td>
<td>Inservice</td>
</tr>
<tr>
<td>Low confidence for teaching science</td>
<td>Pre &amp; Inservice</td>
</tr>
<tr>
<td>Limited science knowledge for the primary science syllabus</td>
<td>Pre &amp; Inservice</td>
</tr>
<tr>
<td>Limited skills for teaching science exacerbated by too little professional development</td>
<td>Inservice</td>
</tr>
<tr>
<td>Insufficient science teaching preparation for lessons during school time</td>
<td>Inservice</td>
</tr>
<tr>
<td>Need for resources, relevant equipment and greater science budget in primary schools</td>
<td>Inservice</td>
</tr>
<tr>
<td>Inadequate mentoring for preservice primary teachers during practicum</td>
<td>Preservice</td>
</tr>
<tr>
<td>Lack of formal science assessment in the Australian primary school</td>
<td>Inservice</td>
</tr>
</tbody>
</table>

As can be seen, problems that characterise preservice primary teachers are their limited science knowledge, dislike of science, low confidence to teach science, and insufficient mentoring to learn how to teach science during teaching practica.

However, improvement of problems regarding the teaching of science by inservice teachers has been reported in Australian primary schools with the implementation of the Primary Connections program of science teaching and learning units with associated resources.
Chapter 3
Literature Review

3.1 Introduction

This chapter will focus on the constructs of interest and self-efficacy. Section 3.2 describes situational interest, its importance to learning, and sources in science and other subjects. The construct of individual interest and its importance to learning and teaching are presented in Section 3.3. The construct of topic interest is presented in Section 3.4. Previous research that investigated a relationship between situational interest and individual interest is examined in Section 3.5. Self-efficacy, its importance and sources, especially in connection with the participants of this study, are presented in Section 3.6. Section 3.7 presents the research questions of this study. The summary of this chapter is found in Section 3.8.

3.2 Situational Interest

Previously described as interestingness (Frick, 1992; Hidi & Baird, 1986), the concept of situational interest was differentiated from other kinds of interest, such as individual interest, by Hidi and Baird (1986) and Hidi (1990). Hidi (1990) defined situational interest as a kind of interest that “tends to be evoked more suddenly by something in the environment and may have only a short term effect, marginally influencing an individual’s knowledge and values” (p. 551). Situational interest was later defined by Hidi and Renninger (2006) as a person experiencing “focused attention and an affective reaction that is triggered in the moment by environmental
stimuli, which may or may not last over time” (p. 113). In other words, situational interest can trigger attention but it is transient, perhaps disappearing as spontaneously as the arousal (Hidi, 1990; Hidi & Anderson, 1992; Hidi & Baird, 1986).

3.2.1 Importance of situational interest

Situational interest plays an important role in learning (Bergin, 1999; Hidi, 1990; Hidi & Baird, 1986; Schraw et al., 2001; Wade, 2001). Although transitory, situational interest aroused in a student can focus his or her attention, assist comprehension, and aid recall of the information to be learned (Mitchell, 1993; Schiefele, 1991; Wade, 2001; Wade et al., 1993). Ainley, Hidi, et al. (2002) also argued that situational interest resulted in an increased willingness to participate in learning. Morgan (2010), for example, investigated whether situational interest could influence the learning behaviours of the students in a tenth grade history class. She used hands-on activities, social interaction, relevance, and discussion to trigger situational interest. She found positive changes in student engagement, focused attention, understanding, recall of lesson content, and students’ test score results.

Rotgans and Schmidt (2011) conducted a study that investigated situational interest and its relationship with learning and academic achievement. Their investigation involved a one day, active-learning economics workshop with 69 polytechnic students. The tasks included self-directed learning activities and collaborative learning in small groups to address skills and subject knowledge for the students’ future profession. The authors concluded that students’ self-reports of high levels of situational interest predicted their learning.
3.2.2 Sources of situational interest in science

The studies described below present some sources of situational interest in relation to science lessons.

Palmer’s (2004b) study with 29 preservice primary teachers identified sources of situational interest that positively influenced their attitudes for the subject of science and future science teaching. From surveys and individual interviews, the sources of situational interest were determined to be involvement from hands-on activities, novelty created by science trivia, surprising or unexpected results, meaningfulness from learning how to teach science for the primary classroom, group work, and personal anecdotes. Palmer (2004a) argued that the science classroom seemed to be the ideal environment to implement sources of situational interest such as hands-on activities for group work, novelty creation, and personal involvement.

Nieswandt (2007) conducted research in chemistry classrooms with 79 grade nine students. The students had not been exposed to formal chemistry before the study and therefore had not experienced any situational interest with respect to formal chemistry lessons. Nieswandt used hands-on activities, demonstrations and everyday life applications for personal relevance during the presentation of chemistry lessons. Her study showed that all were sources of situational interest for chemistry, especially providing students with the opportunity to actively participate in the chemistry lessons.

Palmer (2009) investigated sources of situational interest during an inquiry-based science lesson with small groups of grade nine high school students. The students’ task was based on science topics of air resistance, static electricity, or
buoyancy. Palmer found that novelty was the major source of situational interest, and was created by new learning experiences, surprise, suspense, and variety. Other sources of situational interest included physical activity, choice, and social interaction.

Live animals, such as a guinea pig and cane toad, were used by Dohn, Madsen, and Malte (2009) as a source of situational interest in an undergraduate zoophysiology course. The live animals were intended to provide meaningful, yet humorous experiences to arouse situational interest in students. From surveys and open-ended questionnaires, students did report situational interest in working with live animals.

From field trips with 12th grade students to an aquarium and a zoo for studies in ecology and evolution, Dohn (2011a, 2011b) determined sources of situational interest to be novelty, surprise, physical activity, social interaction, hands-on activities, and enjoyment of learning.

### 3.2.3 Sources of situational interest in other subject areas

Much of the research involving situational interest occurred during the 1990s and was focused on sources of situational interest for reading, writing, and comprehension for learning from text. In more recent times, studies of situational interest sources have expanded into other domains such as mathematics, history, and physical education. Some examples of studies in domains other than science are described to identify sources of situational interest.
**Reading**

Irrespective of genre, particular kinds of text and text themes are sources of situational interest. Some features of these sources may be the intensity of action described in the text and surprising information (Hidi & Baird, 1986). Depiction of life themes and novelty (Anderson, Shirey, Wilson, & Fielding, 1987), as well as vividness (Hidi & Anderson, 1992; Hidi & Baird, 1986; Schraw, Bruning, & Svoboda, 1995) has aroused situational interest. Schraw et al. (2001) asserted that suspense and identification with characters in text were sources of situational interest. Text themes like space travel could also represent a source of situational interest (Hidi, 2001).

Some early studies undertaken by Hidi and Baird (1986, 1988) investigated if particular kinds of text were sources of situational interest. One text had novelty and action as triggers of situational interest. Another text presented important information and the third had incomplete information that the students had to work out. Only the novelty text resulted in high recall but all were found to be sources of situational interest. Schraw et al. (2001) argued that student choice for reading was a source of situational interest, as was well-organised text and knowledge provided by the teacher to assist the students in understanding the information.

**Mathematics**

Investigation of sources of situational interest in mathematics began with the study by Mitchell (1993). Mitchell used puzzles, group work, and computers as sources of situational interest to investigate the relationship between “catching” and “holding” of situational interest in students. The *catch* strategies were meant to
trigger situational interest and the hold strategies were intended to maintain situational interest. Mitchell (1993) found that computers, group work, and puzzles were sources for catching situational interest and meaningfulness for students and active participation were sources for holding situational interest.

Durik and Harackiewicz (2007) used a novelty-based source of situational interest in college mathematics students to investigate the effect of catch and hold stimuli (Mitchell, 1993). The source for catching situational interest was a visually stimulating notebook technique that featured colourful pages, cartoon-like images, and varied fonts. The non-catch technique was a notebook that had plain white pages with black, same size font. The authors found that the novel source did arouse the catch form of situational interest, especially for college students with a lower interest in mathematics.

Matarazzo, Durik, and Delaney (2010) conducted a study with 363 university mathematics students to test if humorous learning materials could be a source of situational interest. Humour may improve task interest for individuals with a low individual interest in mathematics due to its similarity to novelty, another source of situational interest. The embedded humour appeared in the introduction as well as the worded presentation of the problems that involved the solution of two-digit mathematical problems without the use of a pencil and paper. Matarazzo et al. (2010) found that students with a low individual interest for mathematics responded positively to the humour with an increase in interest for the mathematics activity.

History

There has been some research of situational interest in the domain of history.
One study was conducted by Del Favero, Boscolo, Vidotto, and Vincentini (2007) with 100 eighth grade students. They investigated sources of situational interest that could increase student interest after reading historical literature connected to World War 1 and the economic boom. The two sources of situational interest selected were problem-solving in class discussion and individual problem-solving. They found that the major source of situational interest was the social interaction of discussion.

Logtenberg, Van Boxtel, and Van Hout-Wolters (2011) investigated types of introductory text as sources of situational interest for a new history topic. Before the study began, the authors hypothesised that the level of situational interest stimulated by the text could predict the number of questions asked. The higher the level of situational interest, the more numerous would be student questions. The introductory texts were narrative, expository, and issue-raising texts about the development of industry and its related social problems. The type of introductory text did significantly influence the level of situational interest and the kind of questions generated but not the number of questions. The level of situational interest was found to be highest for the narrative text and the issue-raising text.

**Physical Education**

Chen, Darst, and Pangrazi (2001) conducted a study in physical education with 7th, 8th, and 9th grade students to identify sources of situational interest in two different video tasks. The sources were found to be novelty, challenge, attention demand, exploration intention, and instant enjoyment. Of these, instant enjoyment was the main source, while challenge was the least important. Chen and Darst’s (2002) data from students learning basketball skills of chest-passing and pass-
shooting determined that situational interest triggers skill learning during physical activities in the same manner as Chen et al. (2001).

3.2.4 Situational interest research with preservice primary teachers

One study has investigated situational interest amongst preservice primary teachers. Palmer (2004b) had 29 participants in an undergraduate unit combining both science theory and strategies for teaching science, that is, a combined content and methods science unit. He delivered the science theory using simple explanations with a minimum of scientific jargon complemented by “demonstrations, pictures, discussions, personal anecdotes, dramatisations and fun facts (science trivia)” (p. 898). Most of the science activities were hands-on, often with surprising, exciting and unexpected results. All learning activities were designed to arouse situational interest.

Data were collated from formal surveys using the Attitudes Towards Science Inventory developed by Gogolin and Swartz (1992). This survey was administered in week one and week nine of the ten-week course. Two informal surveys were also conducted during the unit asking students to describe on paper what had interested them. Interviews were also undertaken with participants. The data analysis confirmed that situational interest had been aroused. Palmer (2004b) identified the sources of situational interest as:

the teacher’s use of involvement (by using hands-on activities), novelty (by using discrepant events activities and science trivia), meaningfulness (through learning how to teach science, and possibly through understanding science concepts they need to teach), group work (by using hands-on activities) and
personal anecdotes. (p. 905)

The data analysis also revealed participants’ changes in attitudes to science because of situational interest.

3.3 Individual Interest

Individual interest was defined by Hidi (1990) as interest which “develops slowly over time and tends to have long-lasting effects on a person’s knowledge and values” (p. 551). Tobias (1994) defined individual interest as “people’s relatively enduring preferences for different topics, tasks, or contexts and how they influence learning” (p. 38). Hidi and Harackiewicz (2000) defined individual interest as a “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). According to Ainley, Hillman, and Hidi (2002), individual interests are defined as “relatively stable orientations that have developed over time” (p. 412). Hidi and Renninger (2006) defined individual interest as a “person’s relatively enduring predisposition to reengage particular content over time” (p. 113). Thus, individual interest is an enduring predisposition with personal significance that tends to develop slowly as a result of life experiences. Varying from student to student, an individual interest is reflected in the student’s long-term desire to engage in a task or school subject or activities (Renninger, 1992).

3.3.1 Importance of individual interest in learning and achievement

Many studies involving individual interest have been concerned with its effect on learning (Hidi, 1990). Krapp, Hidi, and Renninger (1992) reported that students
are more inclined to learn if the learning situations are in some way related to their individual interest. Krapp et al. (1992) explained that an individual interest has personal significance, and thus holds a student’s attention and promotes effort. Durik and Harackiewicz (2007) suggested that “individuals who enter learning situations with high levels of personal interest in the topic are in an ideal situation, as they are receptive to the information and eager to engage in the learning activity” (p. 598). Students with an individual interest for a subject or task persist longer and enjoy the learning to a greater extent than those without a relevant individual interest (Hidi & Harackiewicz, 2000). In addition, an individual interest can facilitate positive behaviours for learning such as students being willing to ask questions to enhance their learning (Ainley, Hidi, et al., 2002; Hidi, 1990; Pintrich & Schunk, 2002; Renninger, 2000; Renninger et al., 2002; Krapp et al., 1992; Schiefele, Krapp, & Winteler, 1992).

It has been argued that individual interest leads to academic achievement (Krapp et al., 1992; Renninger et al., 2002; Schiefele et al., 1992). For example, academic achievement could be the result of a highly interested student capable of deep processing of information (Schiefele, 1991). Pintrich and Schunk (1996) explained that an individual who demonstrates high individual interest would develop better thinking skills for academic achievement. Krapp (2002) argued that individual interest encourages an eagerness to expand learning, resulting in improved proficiency.

The following study points to the importance of individual interest for learning. Renninger et al. (2002) investigated the use of students’ individual interest as a
support for learning. During their study with 50 students, Renninger et al. (2002) presented case material for three of the students studied who had different individual interests and abilities for reading and mathematics. The study hypothesised that use of well-developed individual interests could promote more effective learning than the use of materials that do not connect to students’ individual interests. Mathematics problems placed within contexts of well-developed individual interest influenced students’ urge to understand and to solve problems. With expository text, Renninger et al. (2002) found that:

- well-developed and less-developed interest inserted into passages as contexts indicate that students are likely to recall more points, recall information from more paragraphs, recall more topic sentences, write more sentences, provide more detailed information about topics read, make no errors in written recall, and to provide additional topic-relevant information when given passages with contexts for which they have well-developed rather than less-developed interest. (p. 473)

With the inclusion of well-developed individual interest information in the mathematics problems and expository text, Renninger et al. (2002) found the three 11-year-old students were able to perform their tasks better than expected. It seemed that the students were able to focus more on the meaning and the demand of the tasks. In comparison, low individual interest with its lower knowledge and value reduced student understanding. Additionally, the authors argued that individual interest related to reading and mathematics encouraged student questioning. The questioning promoted “connections between the contexts of well-developed interest
and the subject matter to be learned” (Renninger et al., 2002, p. 487).

O’Keefe and Linnenbrink-Garcia (2014) demonstrated that students working on word puzzles they found interesting performed better than students who did not find the word puzzles interesting. The researchers described the interested students as working “in the zone”, Csikszentmihalyi’s (1997) well know term to describe a flow state of being fully absorbed and fully focused on a task. In spite of these advantages, individual interest does have limitations. One disadvantage for teachers is that it is difficult to make use of all students’ individual interests to support learning (Hidi, 1990). Teachers would have to design classroom programs to suit each student’s individual interests. This difficulty would be exacerbated by large classes. Teachers may have control of the learning environment with respect to the selection of learning strategies but not over the many differing individual interests that students bring with them (Hidi, 1990; Hidi & Anderson, 1992).

3.3.2 Teachers’ individual interests

There is limited research evidence for a relationship between a teacher’s individual interest for a subject and student achievement. Research tends to focus on student interest, seldom on teacher interest (Long & Woolfolk Hoy, 2006). Long and Woolfolk Hoy (2006) argued that effective teachers who succeed in facilitating student learning may have strong individual interest in their teaching subject. This was determined from surveys of 12th grade students (N = 112) who each nominated a teacher they perceived as being interested in their subject and who had helped them to learn.
3.3.3 Preservice primary teachers’ individual interest in science

Few studies have been conducted with respect to preservice primary teachers’ individual interest in science. One study, in an inquiry-based science methods course, was conducted by Jarrett (1999). Using 112 trainee primary teachers in a master’s program, Jarrett examined the effect of previous science experiences in primary school, high school, college, and informal science activities on students’ science interest. She found that poor science learning experiences as early as primary school could significantly affect individual interest for science. From the data, 63% of the trainee teachers’ responses were negative for primary science. In comparison, a good primary school experience had a significant positive impact on individual interest in science. Jarrett argued that poor science experiences for students in primary school may adversely affect their interest in later years, particularly if they intended to teach primary science. In addition, Jarrett showed that hands-on activities increased the individual interest of the participants.

Bulunuz and Jarrett (2010) also studied the relationship of preservice primary teachers’ prior experiences in science with their interest in science. They found that 42% of the preservice elementary teachers ($N = 53$) indicated that they had low interest in science, mainly as a result of unsatisfactory experiences during their school years. They noted that “the major difference between the preservice teachers who were interested and uninterested in science were memories of elementary school science and quantity and importance of informal science experiences and activities” (p. 78). Bulunuz and Jarrett (2010) concluded that it was important to provide interesting experiences during primary science education to support the development
of a long-lasting individual interest. The authors commented:

methods classes that help teachers develop memorable science lessons and that help them incorporate elements of informal science in the classroom may encourage the development of future generations of teachers interested in science and motivated to make science memorable for their students. (p. 78)

### 3.4 Topic Interest

Topic interest is a third kind of interest that has been proposed alongside situational interest and individual interest. There is disagreement about the nature of topic interest and its connection with situational interest and individual interest. It is important to discuss this construct because it is a closely related construct. This section provides definitions of the construct and a brief review of the research into text-based topic interest and science-based topic interest.

Ainley, Hillman, et al. (2002) defined topic interest as “the level of interest triggered when a specific topic is presented” (p. 545). Schiefele and Krapp (1996) argued that topic interest was a form of individual interest and defined it as “a relatively enduring evaluative orientation towards certain topics” (p. 141). Kerger, Martin, and Brunner (2011) defined topic interest as an “anticipatory response triggered by the presentation of topics and themes” (p. 608), and argued that it was a consequence of the sum of situational interest and individual interest.

#### 3.4.1 Text-based topic interest

Hidi and McLaren (1990) first used the term “topic interest” and they considered it as a form of situational interest. They conducted a study with 4th-5th
grade students to assess their interest for topics and themes in social science textbooks. They found that student ratings for topic interest indicated a triggering of transient situational interest. This was determined by the students’ emotional reactions to the topics that were not related to the students’ individual interests.

In their study, Schiefele and Krapp (1996) described topic interest as a subgroup of individual interest, and that found that it was significantly related to learning. Like individual interest, topic interest was relatively enduring and reflected how students felt towards a specific topic. However, the authors argued that topic interest was not quite the same as individual interest because individual interest could also include material objects and activities in addition to subject knowledge and topics (Schiefele & Krapp, 1996).

Ainley, Hillman, et al. (2002) argued that both situational interest and individual interest can influence topic interest, either separately or together:

In summary, the level of topic interest triggered when a student is presented with a set of text titles might be the outcome of a well-developed individual interest. It might be an immediate response to specific features of the text title, situational interest. Or, it might represent the outcome of both individual and situational interest factors. (p. 413)

Ainley, Hillman, et al. (2002) investigated the contribution of individual interest and situational interest to topic interest. The study involved 10th grade students ($N = 86$) in an Australian school and their reaction to four novels. Variations in level of interest emerged initially with the titles of the novels suggesting an aspect of situational interest. For example, the book title “The Blooding”, by itself, aroused
situational interest among students. In addition, there was evidence that students’ individual interests (measured prior to their response to the novels) affected their level of topic interest. The authors argued that both situational interest and individual interest influenced topic interest in the novels, though situational interest outweighed individual interest.

### 3.4.2 Science-based topic interest

Trend (2005) hypothesised that topic interest was created by the combined effect of situational interest and individual interest. His study with eleven and twelve year old students ($N = 652$) in 27 classrooms aimed to ascertain the level of existing topic interest related to geoscience in the school curriculum. Each student was asked to complete a 28-item questionnaire and an open-ended questionnaire before any geoscience lessons. Individual interest was rated by a student’s interest in finding out more about specific topics described in the items. Two examples of questionnaire items were “What exactly was the big event that killed off the dinosaurs?” and “What causes some volcanic eruptions to be massive and explosive?”

Trend argued that any topic interest revealed in the data reflected students’ strong individual interest for a topic. The results indicated that topic interest was not due to transient situational interest and not due to the combined effect of situational interest and individual interest as he had hypothesised. Trend concluded that it was not possible to establish topic interest as a robust construct that was dependent on both situational interest and individual interest.

Kerger et al. (2011) conducted an investigation with 294 grades eight and nine students to see if “feminised” physics and biology topics could enhance science topic
interest for girls. The authors considered that topic interest was “characterized by an anticipatory response triggered by the presentation of topics and themes and that can result from activated individual interest as well as from situational interest” (Kerger et al., 2011, p. 620). For physics topics, for example, the use of lasers for cosmetic surgery might be expected to appeal to female students and the power of lasers would appeal to boys. A “feminised” biology topic was learning how to care for the skin. In comparison, a “masculine” topic was the composition of blood. Students completed an 80-item survey on a variety of science topics. Girls did indicate increased topic interest for the feminised science topics. However, the authors noted that the “feminine” and “masculine” physics and biology topics focused on different underlying scientific concepts. For example, the effect of a laser on the skin (“feminine” topic) was different from learning about the power of a laser (“masculine” topic). Thus, the concepts themselves may have been more interesting to girls, and not the feminised topics that were hypothesised to be the major causes of enhanced science topic interest (Kerger et al., 2011).

Thus, the status of topic interest is still an open question because it appears to have some overlap with both situational interest and individual interest. As a result, it will not be examined as a construct in this study. Rather, students’ ongoing interests will be referred to as individual interests and their transitory interests will be categorised as situational interest.
3.5 Relationship between Situational Interest and Individual Interest

A number of researchers have proposed that regular experiences of situational interest can promote individual interest (Del Favero et al., 2007; Hidi, 1990; Hidi & Anderson, 1992; Hidi & Baird, 1986; Hidi & Renninger, 2006; Krapp, 2002, 2007; Mitchell & Gilson, 1997; Randler & Bogner, 2007). In this section, some early conceptualisations of a relationship between situational interest and individual interest are presented. Recent models of interest development as proposed by Hidi and Renninger (2006) and Krapp (2007) are examined. Finally, eight studies that have investigated the relationship between situational interest and individual interest will be considered.

3.5.1 Early considerations of the relationship between situational interest and individual interest

Early literature on the relationship between situational interest and individual interest often focused on text-based interest. Hidi and Baird (1986) argued that the interaction of situational interest and “interest within a person” ensured a process of continuing interest. In her comprehensive review, Hidi (1990) proposed that situational interest and individual interest affect each other, that situational interest, produced from the interaction of the person and the environment, contributes to a long-lasting individual interest. Conversely, a person with an established individual interest may react more strongly to environmental situational interest than a person with less individual interest. Hidi and Anderson (1992) also suggested that regular situational interest generated by stimuli in the environment could promote the growth of knowledge and value which are requisites for an enduring individual interest.
3.5.2 Models of interest development

In more recent years, two important models have been proposed to explain how regular experiences of situational interest may promote individual interest. These models by Hidi and Renninger (2006) and Krapp (2007), are discussed here.

Hidi and Renninger (2006) proposed a Four Phase Model of Interest Development that progressed through sequential phases beginning with the initial arousal of situational interest and ending with well-established individual interest. The first phase of this interest development model was the triggering of situational interest by an attention-focussing, engaging situation. This allowed the first links between person and content to be established. The second phase was the maintenance of situational interest stimuli which occurred during learning experiences over an extended period. This promoted some personal involvement, more positive feelings, more knowledge, and perceived value for the information. The third phase was the nurturing of an emerging individual interest as positive feelings become stronger and the individual begins to seek answers to questions arising from individual interest. The fourth phase was a well-developed individual interest characterised by long-term positive feelings, personal significance, and expanding knowledge. In this phase, the individual does not require external support and is eager to pursue more information without external direction.

Krapp (2007) also argued for a relationship between situational interest and individual interest. He proposed a three stage model of individual interest development, with the first stage as the triggering of situational interest to arouse curiosity. The second stage was the maintenance of situational interest. Sustained
situational interest should lead to the third stage, an established and enduring individual interest. Krapp further proposed that individual interest is influenced by two psychological systems that operate independently of each other. One system is a person’s values and goals. The other is a person’s emotional response to the area of interest. He hypothesised that individual interest would only develop if values, goals, and emotions were positively experienced at the same time. Sustained experiences that satisfy a person’s goals and emotional needs would then support the emergence and development of a stable individual interest.

The models of interest development by Hidi and Renninger (2006) and Krapp (2007) were similar in that they both proposed that a learner’s sustained exposure to situational interest in the environment may support the development of an individual interest. Hidi and Renninger’s model was based on the underlying differences between situational interest and individual interest with knowledge, values, and positive feelings varying in each sequential phase. Krapp argued that interest development also depended on two separately operating, psychological systems of values, goals, and emotions that guided the growth of the learner’s individual interest.

3.5.3 Studies of a relationship between situational interest and individual interest

Although it has been proposed on many occasions that regular experiences of situational interest will enhance individual interest, relatively few studies have tested this proposal empirically. Several studies have been selected for inclusion in this section because they have investigated a relationship between situational interest and
individual interest. The studies reported in this section will be examined closely because the argument that situational interest can enhance individual interest is central to this thesis.

*Mitchell and Gilson (1997)*

Mitchell and Gilson’s (1997) study investigated whether high situational interest aroused by the learning environment could substantially increase students’ individual interest for mathematics. The study included students from fifth grade up to graduate level students ($N = 598$) with 25 different teachers. These teachers were identified prior to the study as being capable of providing mathematics lessons high in situational interest.

Mitchell and Gilson used an Interest Survey previously shown to have reliability and construct validity by Mitchell (1993). The Interest Survey was designed with a six point Likert scale ranging from one for “strongly disagree” to six for “strongly agree.” Approximately half of the survey items were negatively worded, to be reversed for analysis. One example of a survey item for measurement of situational interest was “our math class is fun.” An item in the Interest Scale for measuring individual interest was “I think mathematics is really boring.”

A presurvey was undertaken on the participants’ first day of class to obtain information about prior individual interest for mathematics. This survey did not contain any items related to situational interest. The postsurvey Interest Scale included items for both situational interest and individual interest. It was administered at the end of the course, 14-16 weeks after the presurvey.

Analyses of the data showed that students in classroom environments enriched
with regular sources of situational interest experienced an increase in individual interest. The authors noted that it could take 14 to 16 weeks for a positive change in individual interest to develop. They concluded that “we may have to re-think the relatively stable, unchangeable nature of individual interest” (p. 22). However, it should also be noted that there were only two points of measurement in the study.

**Mitchell (1997)**

In addition to Mitchell and Gilson’s (1997) large study, Mitchell (1997) investigated if high situational interest aroused in the learning environment could increase individual interest in a statistics classroom. The participants were 51 grade ten students and 70 doctoral level graduate students of the original 598 participants in Mitchell and Gilson’s study. The grade ten students were undertaking a “Statistical Thinking” curriculum and the graduate students were studying the importance of statistics in evaluating an educational dilemma. This study used the same methodology for data collection and analysis as Mitchell and Gilson. Mitchell (1997) also demonstrated that high situational interest increased individual interest especially for students who had low pretest individual interest scores.


To answer the question why some students developed an interest in a university course, Harackiewicz et al. (2000) conducted a longitudinal study with 648
university students. These students were undertaking a one semester introductory psychology course presented only in lecture format. One of the study’s goals was to investigate the relationship between situational interest and individual interest.

As part of a pretest, two to three weeks after the course began, Harackiewicz et al. (2000) measured students’ mastery goals using an 18-item questionnaire. It was argued that mastery goals would stimulate students’ situational interest in the course. One example of a mastery item in the questionnaire was “I want to learn as much as possible in this class.” After two examinations and just prior to the final examination, a thirteen item Likert-response questionnaire measured situational interest. This questionnaire made a distinction between triggered situational interest from enjoyment of lectures and a more meaningful interest in psychology from maintained situational interest. Samples of these “catch” and “hold” items for situational interest (from Mitchell, 1993) respectively were “I think what we are learning in this class is interesting” and “I think the course material in this class is useful for me to learn.” This interest scale also measured individual interest for psychology with items such as “I would like to take more psychology classes after this one.” Long-lasting interest, that is individual interest, would be determined by the number of psychology credits the students accrued over a period of three semesters after the study.

The research showed a relationship between situational interest and individual interest. Higher ratings of enjoyment of the lectures and instructors indicated higher situational interest aroused in students. Student enrolment in another psychology course or a choice to major in psychology, after the introductory course was
completed, was used as a measure of long-lasting individual interest. Approximately 23% of the original 648 participants continued to complete other psychology courses. Departmental records had previously shown that about 10% of students usually elected to major in psychology after the introductory course.


Harackiewicz et al. (2008) extended the study of Harackiewicz et al. (2000) using 858 participants undertaking a university psychology course. They demonstrated that participants’ adoption of mastery goals could generate situational interest that could in turn promote individual interest in psychology. Continued individual interest was determined over the following seven semesters using information from students’ academic records. In comparison to the methodology of Harackiewicz et al. (2000), the authors measured situational interest at the end of the semester before any examinations to examine the effect of situational interest without any contamination from later academic results. The researchers argued that their results supported Hidi and Renninger’s (2006) four phase model of interest development from situational interest to individual interest.

Linnenbrink-Garcia, Durik, Conley, Barron, Tauer, Karabenick, and Harackiewicz (2010)

The study of Linnenbrink-Garcia et al. (2010) was designed to develop a valid situational interest measurement scale for wider use in research. This instrument contained three measures: triggered situational interest, a maintained feeling of situational interest characterised by engagement and enjoyment, and a maintained situational interest value leading to an emerging individual interest. The participants
were university psychology students \((n = 858)\) from the study of Harackiewicz et al. (2008) and middle and high school mathematics students \((n = 284)\) from seventh to twelfth grade. They found that situational interest measured early in the school year was able to predict change in individual interest over the school year.

This group of middle school and high school students became the participants of their next study \((n = 246)\). A more refined survey aimed to distinguish between situational interest and individual interest including a longitudinal component to assess if situational interest had developed into individual interest over time. The authors reported that their final data provided “preliminary evidence to suggest that situational interest is distinct from individual interest and can promote the development of individual interest” (p. 668). The authors concluded that their survey could be used to understand the experiences that trigger situational interest that promotes individual interest.

**Chen and Darst (2002)**

Chen and Darst (2002) conducted a study on the learning of basketball skills. The study included an investigation of a relationship between situational interest and individual interest. The participants were middle school students from 7th and 8th grade, girls \((n = 109)\) and boys \((n = 82)\). Was skill accomplishment related to situational interest and individual interest during the learning of chest-passing and pass-shooting skills?

The individual interest survey used by Chen and Darst was a seven point Likert-style format requiring students to rate various sports including basketball. Each sport was rated at seven for high individual interest and one for low individual
interest. The second survey was a five point 24-item Likert-style Situational Interest Scale designed by Chen, Darst, and Pangrazi (1999) to measure students’ situational interest aroused during the learning of skills. Two examples of items in this scale were “This activity is exciting” and “This is an exceptional activity.”

Data collection for individual interest and situational interest occurred in two stages. The first survey was conducted prior to the treatment to determine individual interest for basketball compared to seven other regularly offered sports in the school’s physical education curriculum. At the end of skills instruction, skills tests for chest-passing and pass-shooting were undertaken by the students. After each test, one week apart, students’ situational interest was measured.

The rating scores for basketball compared to other sports represented students’ individual interest in basketball. For situational interest, girls experienced an increase in situational interest from one skill (chest passing) to the next (pass shooting) while the boys’ scores of situational interest decreased from one skill to the next. However, both girls and boys experienced situational interest arousal when they learned the pass-shoot skill. Chen and Darst (2002) concluded that the levels of situational interest generated in the students by the two tasks were not related to their individual interest. That is, in this study, situational interest (in learning basketball skills) and individual interest (interest in basketball) were independent of each other.

However, more sophisticated statistical analyses (hierarchical linear modelling) showed that there was an association among high situational interest, high individual interest, and high skill level. The authors reasoned that this was indicative of an interweaving of situational interest with individual interest because some students
had reached a high level of competence for the skills. They argued that “both individual and situational interests may play a role in learning a physical movement task” (p. 266).

**Del Favero, Boscolo, Vidotto, and Vincentini (2007)**

Del Favero et al. (2007) investigated if the arousal of situational interest in history students, using problem-solving, could lead to a stable individual interest in history. The eighth grade students ($N = 100$) were divided into two groups for learning two history topics about World War I and the economic boom. The two groups ($n = 52$ and $n = 48$) were organised from four classes of middle school students with different teachers. While the historical documents were the same for both groups, the history lessons had different sources of situational interest. These sources of situational interest were individual problem-solving and solving problems through group and whole-class discussion.

A questionnaire was administered for the situational interest component. There were 19 items with a four point Likert scale. One representative item of situational interest was “I felt I was active in the learning activities on World War I.” An item such as “I think World War I is easy to understand” reflected situational interest stimulated by the understanding the history topic. An item that measured the level of arousal of situational interest by the activities in the study was “I found the learning activities on World War I fun.” For the development of individual interest in history, 21 items on a four point scale were completed by the students. Del Favero et al. (2007) used items measuring positive emotions and values, reflecting Schiefele’s (1991) concept of individual interest. Two examples of items for individual interest
were “I think that understanding the causes of past events is useful to understand what happens nowadays” and “I like watching documentaries about historical topics.”

Two history topics were taught four months apart. The topic of World War 1 was followed by the topic of the economic boom. Individual interest measurements were made prior to beginning each topic and immediately at the end of each topic. Situational interest was measured in a posttest only after each topic was completed.

With respect to situational interest, group and whole-class discussion problem-solving was rated as more (situationally) interesting than individual problem-solving. Regardless of the situational interest triggering strategy used, there was a significant increase in individual interest for all participants between the pretest and first posttest of the World War 1 topic. There was no significant gain in individual interest from the pretest to the posttest for the second topic, the economic boom. This indicated that the increased individual interest from the World War 1 topic had been maintained to the end of the economic boom topic. As a result of situational interest aroused from the instructional strategies of individual problem-solving and solving problems through group and whole-class discussion, the authors concluded that an increase in individual interest in history had occurred for all students.

Randler and Bogner (2007)

Randler and Bogner (2007) conducted research with 490 German secondary school students from two different levels of school performance and ability. The participants were from grade nine of middle level ability ($n = 170$) and grade eight of high level ability ($n = 320$). One of the study’s aims was to determine if situational
interest could enhance individual interest in ecology. The actual content of fourteen ecology lessons acted as situational interest to determine if there was a relationship between situational interest and individual interest for ecology.

The authors administered a survey to examine individual interest. Did the students want to know more about a particular area of the ecology unit titled “Ecosystem Lake”? For example, Item Two measured how much a student wished to know about “how a dragonfly grows up.” Another survey collected data about situational interest aroused by the actual content of the ecology lessons. One sample item for situational interest was “The lesson was interesting for me.” Five collections of data were undertaken. Two involved individual interest for ecology: before starting the course and immediately on completion of the course. The situational interest surveys required participants’ ratings immediately after three preselected lessons.

The researchers found no evidence for an increase in students’ individual interest during the ecology unit. In fact, there was a significant decrease in individual interest and decreasing situational interest during the unit. They suggested that the decline of individual interest during the ecology unit may have been due to students’ satisfying their interest in ecology shortly after the pretest.

Any situational interest reported by the students did not enhance a long-lasting individual interest for ecology. Nonetheless, Randler and Bogner argued that situational interest was desirable in the learning environment even if it did not translate into longer term individual interest.
3.5.4 Summary of studies described in Section 3.5.3

The studies that did show a relationship between situational interest and individual interest were the following: the mathematics studies of Mitchell and Gilson (1997) and Mitchell (1997), the psychology studies of Harackiewicz et al. (2000) and Harackiewicz et al. (2008), the study involving both psychology and mathematics students (Linnenbrink-Garcia et al., 2010), the physical education study of Chen and Darst (2002), and the history study of Del Favero et al. (2007). On the other hand, Randler and Bogner (2007) found no link between situational interest and longer term individual interest: “there was no evidence that interest increased during the educational unit which could produce a higher interest afterwards” (p. 474).

In general, these studies provide guarded support for a relationship between regular arousal of situational interest and the development of individual interest. To date there has been no study that examines this relationship for the discipline of science using a sample of primary teacher education students. Given that these students often have little interest in science and lack science knowledge, it would be desirable to show that regular experiences of situational interest in science could encourage a long-term individual interest in science.

Some of the studies examined in this section examined individual interest at two points only, before and after an intervention involving situational interest. Other studies followed participants for longer after the intervention, to provide more evidence of long-lasting individual interest. Because individual interest is a stable, long-lasting interest (Hidi, 1990; Tobias, 1994; Hidi & Harackiewicz, 2002; Ainley, Hidi, et al., 2002), a delayed posttest could provide additional evidence that
situational interest had developed into an enduring individual interest in a subject area.

3.6 Self-Efficacy

The main focus of this study is the relationship between individual and situational interest. In addition, this study will investigate the relationship between situational interest and self-efficacy to teach.

This section first describes self-efficacy. Sources of self-efficacy proposed by Bandura (1997) are presented followed by an examination of the role of teaching self-efficacy for teachers and preservice teachers. Sources for developing self-efficacy to teach in preservice primary teachers are described. Included here are studies that have investigated the effectiveness of the types of science units that may develop students’ teaching self-efficacy during teacher training. A summary of what is known about preservice primary teachers’ self-efficacy for teaching science completes this section.

3.6.1 What is self-efficacy?

Bandura (1977) introduced the concept of self-efficacy to explain behavioural change. He defined self-efficacy as “the belief in one’s capabilities to organize and execute the courses of action required to produce given attainments” (Bandura, 1997, p. 3). He further argued that a person’s self-efficacy was not a reflection of their actual skills but a perception of what they could accomplish with any skills they did possess (Bandura, 1986). Often viewed interchangeably with self-confidence (Appleton & Kindt, 2002; Palmer, 2006b; Watters & Ginns, 2000), although self-
efficacy is more task specific than self-confidence, self-efficacy is highly predictive of tenacity for a task (Bandura, 1986). A related construct is outcome expectancy. Bandura proposed that outcome expectancy is “a person’s estimate that a given behaviour will lead to certain outcomes” (Bandura, 1977, p. 193).

Tschannen-Moran et al. (1998) argued that “greater efficacy leads to greater effort and persistence which leads to better performance” (p. 233). Bandura (1997) also theorised that the level of efficacy people bring to specific tasks plays an important role in their success or failure to complete those tasks. A person with high self-efficacy will believe they are capable of learning a task well and judge they have the ability to perform that task, particularly if the task is considered a difficult one.

### 3.6.2 Bandura’s sources of self-efficacy

It was proposed by Bandura (1977, 1997) that self-efficacy could result from four potential sources: mastery experiences, vicarious experiences, verbal persuasion, and physiological and affective states. Mastery experiences comprise actual performance based on personally experienced successes and failures. The mastery of tasks was considered by Bandura (1977) to be the most valuable, authentic source for enhancing self-efficacy.

Vicarious experiences or observation of modelling of a task by another was classed by Bandura as the second most powerful source of self-efficacy. This was especially important if the observers perceived the person modelling the task as having similar ability to them. Nonetheless, Bandura (1997) considered that modelling was not as significant in building self-efficacy as actual experiences of success and failure.
Bandura’s third source of self-efficacy was verbal persuasion, described as feedback that could encourage an individual to make a greater effort to succeed. This could promote a positive perception of potential achievement. However, this advice was dependent upon the credibility of the person who was providing the verbal persuasion and the quality of the feedback. Bandura (1997) advised that positive changes in self-efficacy came through “compelling feedback that forcefully disrupts the preexisting disbelief in one’s capabilities” (p. 82).

The fourth source of self-efficacy was the physiological and affective state experienced by the person. A positive emotional state should potentially increase the perception of self-efficacy (Bandura, 1997). In comparison, stress could have a negative effect on the person’s perceived capability. Being stressed may act as a cue for people to doubt their ability to be successful.

### 3.6.3 Teaching efficacy and its importance

Ashton (1984) described teaching efficacy as “the extent to which teachers believe that they have the capacity to affect student performance” (p. 28). According to Ashton, the higher a teacher’s perceived self-efficacy for their role of teaching, the greater was their sense of accomplishment in their instructional skill.

With respect to classroom teaching, Bandura (1993) argued that teachers with high perceived self-efficacy for teaching had an easier time promoting student learning and achievement. Furthermore, Bandura (1997) argued that high self-efficacious teachers, compared to low self-efficacious teachers, had a stronger commitment to teaching demonstrated by conscientious efforts to guide student learning. Woolfolk Hoy (2003) showed that self-efficacious teachers were more
willing to trial new strategies in an attempt to enhance learning. In contrast, teachers who possessed low self-efficacy for teaching tended to use familiar strategies such as teacher-directed instruction including text-based instruction (Appleton & Kindt, 2002).

3.6.4 Science teaching efficacy of preservice primary teachers

It is important to enhance the science teaching self-efficacy of preservice primary teachers. As reported in the previous chapter, many preservice primary school teachers struggle with science and have low self-efficacy beliefs about their ability to teach science (Bleicher, 2007; Bursal, 2012; Jarrett, 1999; Palmer, 2006a, 2006b; Watters & Ginns, 1995; Yates & Goodrum, 1990). Preservice primary teachers’ lack of confidence in teaching science can be the result of inadequate knowledge of science (Bleicher, 2007; Ginns & Watters, 1995; Palmer, 2006b). A trainee teacher’s low self-efficacy for teaching science is likely to impact negatively on their future teaching. Science may not be taught at all or be taught poorly (Ginns & Watters, 1999; Palmer, 2006a).

3.6.5 Strategies for enhancing the science teaching efficacy of preservice primary teachers

A number of authors have investigated the potential of different types of science units to improve self-efficacy for teaching primary science (Bursal, 2012; Jarrett, 1999; Palmer, 2006b; Rice & Roychoudhury, 2003; Watters & Ginns, 2000). Traditionally, there are two ways in which preservice primary teachers are prepared to teach science: a science methods unit to develop knowledge of how to teach scientific concepts; and a science content unit to build science knowledge. A third
way is a combined science methods and content unit which merges science content with the pedagogy of teaching science. Studies that use these types of units are described below. Also included is another potential source of science teaching self-efficacy, that is, the practicum conducted as a component of education courses.

**Science methods units**

Research on improving the science teaching self-efficacy of preservice primary teachers has been conducted in science methods units. Palmer (2006a) argued that “well-designed science education courses can produce significant positive changes in efficacy beliefs” (p. 655). Studies have shown that a sense of self-efficacy can be significantly increased by using hands-on activities, inquiry-based learning, group work, discussion, and modelling of instructional strategies (Bleicher, 2007; Bursal, 2012; Jarrett, 1999; Palmer, 2006b; Watters & Ginns, 2000). For example, Palmer (2006b) described the main sources of self-efficacy in his study as “cognitive pedagogical mastery” in which trainee teachers gained knowledge of science teaching techniques, and “cognitive self-modelling” which occurred when students imagined that they were teaching in the classroom. This was facilitated by the modelling of teaching for the primary classroom from the instructor, especially when using hands-on, group work, and discussion strategies. Another source of self-efficacy was “cognitive content mastery”, described as the experience of success in understanding science content.

Bleicher (2007) investigated relationships between preservice elementary teachers’ understanding in science and self-efficacy to teach science ($N = 70$). Bleicher proposed that preservice primary teachers’ negative attitudes towards
science that existed before beginning a science methods unit could be reduced or eliminated as a consequence of the strategies used in the unit. He used a variety of teaching strategies including inquiry based and direct instruction, class discussions to assist students in understanding everyday events, cooperative group work, hands-on activities, and problem-solving activities. He concluded that improved understanding of science from a student-centred approach to learning resulted in an increase in primary trainee teachers’ self-efficacy.

Bleicher argued that the self-efficacy for science teaching became stronger as they continued the science methods unit. Participants’ personal journals contained reflections about improved understanding in science. Additionally, gains were evident in participants’ personal science teaching efficacy data (PSTE) as well as science teaching outcome expectancy (STOE) in the Science Teaching Efficacy Beliefs Instrument (Enochs & Riggs, 1990).

**Science content units**

In comparison to the success of science methods units, science content units have been found to be relatively ineffective in modifying low self-efficacy for primary science teaching (Howitt, 2007; Morrell & Carroll, 2003). For example, Morrell and Carroll (2003) compared the development of self-efficacy of preservice elementary teachers while undertaking two different units, a science content unit and a science methods unit. The study was not designed to investigate the structure and components of either unit type, only the students’ science teaching self-efficacy as a result of each unit. The authors utilised the Science Teaching Efficacy Belief Instrument Form B or STEBI-B (Enochs & Riggs, 1990) to survey students’
self-efficacy, and this was completed by the students at the beginning and end of each unit.

There were 342 students who had matching pretest and posttest data that were suitable for analysis. For science content classes there was no significant increase in personal science teaching efficacy or in science teaching outcome expectancy, the two subscales of the STEBI-B instrument. In comparison, significant increases on the instrument occurred for all science methods classes. The authors concluded that the science methods unit positively influenced self-efficacy for teaching science whereas the science content unit did not.

Howitt (2007) reasoned that a science content unit did not enhance self-efficacy to teach science because science content instructors often wrongly “assumed that increased science knowledge would lead to improved attitudes towards science and increased confidence to teach it” (p. 43). Research in science content courses had led to conflicting results that underlined the importance of including other factors to prepare trainee primary teachers. Ginns and Watters (1999) argued that science content units should present knowledge particularly relevant to the primary teaching role. Furthermore, science content had to be interesting and applicable to everyday life and taught by credible role models to demonstrate appropriate teaching techniques. The effectiveness of science content units in improving the science teaching self-efficacy of preservice primary teachers is still an open question.

**Combined science methods and science content units**

Science method units and science content units are most often conducted independently for primary teacher education. However, Abell and Roth (1992)
argued that “science content courses for preservice elementary teachers may be more effective if they are taught in conjunction with elementary science education methods courses instead of separately and prior to the methods course” (p. 593).

One study by Palmer (2001) has been conducted in a combined science methods/content unit. The unit catered for 30 trainee primary teachers and was designed to “improve the students’ knowledge of science content, to give them an understanding of teaching methods for science, and to have a positive influence on their self-efficacy for science teaching” (Palmer, 2001, p. 126). The aim of the research was to investigate the factors that could enhance self-efficacy for teaching science.

The unit introduced science content knowledge relevant to the scientific concepts of the primary school syllabus, and appropriate science teaching methods were included to demonstrate how to teach the science content. Participants reported gains in self-efficacy from observing the instructor demonstrate how to teach children the required science with a variety of strategies. Examples of these teaching techniques were hands-on activities, science trivia, anecdotes, dramatisations, and demonstrations. This was an interesting study because the teaching techniques that reportedly enhanced self-efficacy were similar to the techniques that have been proposed to promote situational interest.

**Primary teacher practicum**

While the trainee teacher practicum was not a component of the present study, it is an important source of self-efficacy for teaching science. Mulholland and Wallace (2001) argued that the teaching practicum should provide opportunities for
preservice primary teachers to experience sources of self-efficacy. For example, a preservice primary teacher may develop a sense of self-efficacy from successfully teaching science lessons during practicum. These mastery experiences would allow trainee teachers to believe that they will be capable of teaching science in their future classrooms. Verbal persuasion from a cooperating teacher during practicum also may provide supportive feedback. Having vicarious experiences in observing others conduct science activities in a classroom environment may encourage a positive judgement about one’s own ability to teach science.

3.6.6 What is known about preservice primary teachers’ self-efficacy for teaching science

Science education in the Australian primary school has suffered as a result of low self-confidence of teachers and their resulting reluctance to teach science (Appleton, 2002; Ginns & Watters, 1999; Skamp, 1991; Watters & Ginns, 2000). Improving the science teaching self-efficacy of preservice primary teachers therefore is desirable. Science methods units have been shown to be effective in doing this through the inclusion of student-centred activities, such as hands-on activities, inquiry-based learning, and group work. On the other hand, science content units have been less successful in enhancing the self-efficacy of preservice primary teachers. The current study made use of a science content unit that has been designed to be relevant for preservice teachers. It was taught using a variety of techniques appropriate to the primary classroom. Would a course like this enhance self-efficacy to teach science?
3.7 Research Questions of This Study

Studies reviewed in this chapter have focused on situational interest, individual interest, and self-efficacy. There is evidence that the sustained use of strategies to arouse situational interest in a science content area can lead to long-term individual interest. However, this link has not as yet been investigated with primary preservice students. It has also been noted that some of the teaching techniques designed to stimulate situational interest also are likely to enhance self-efficacy. What are the relationships among situational interest in science, individual interest in science, and self-efficacy to teach science?

The following research questions guide the current study:

1. Can situational interest be successfully aroused during a science content unit for primary teacher education students, and if so, how does this occur?
2. Can strategies designed to generate situational interest in science enhance preservice primary teachers’ long-term individual interest in science?
3. Can self-efficacy for teaching science be enhanced by use of strategies designed to arouse situational interest in science?

3.8 Summary of Chapter 3

Situational interest is a short-term form of interest triggered by factors in the immediate learning environment (Hidi, 1990; Hidi & Anderson, 1992; Hidi & Baird, 1986). Situational interest is important for learning because it focuses students’ attention and increases comprehension and recall of information (Schraw & Lehman, 2001; Wade, 2001; Wade et al., 1993).
While much of the early research on situational interest has focused on texts and how to capture students’ interest, situational interest has been investigated in other academic domains such as mathematics, physical education, history, and science. Varied sources of situational interest have been identified in these studies. They include the following: particular kinds of text, hands-on activities, group work, demonstrations, novelty, challenge, attention demand, exploration intention, instant enjoyment, humour, live animals, surprise and suspense, fun facts, field trips, and personal relevance, games and puzzles, individual choice, meaningfulness, discussion, and social interaction. The current study will make use of some of these sources in an attempt to arouse situational interest in science.

Individual interest is a personal preference that develops slowly and tends to be long-lasting. A strong individual interest promotes learning. It has been linked to better understanding, increased recall, more attention and effort, increased enjoyment of learning, and improved thinking skills (Ainley, Hidi, et al., 2002; Harackiewicz et al., 2000; Harackiewicz & Durik, 2003; Hidi, 1995; Krapp et al., 1992; Pintrich & Schunk, 2002; Renninger, 2000; Renninger et al., 2002; Renninger, 2009).

According to Hidi and Renninger (2006), researchers often show that individual interest had developed during their study but they have not addressed the reason how individual interest had developed. More research is required to determine how an individual interest may develop (Hidi & Harackiewicz, 2002).

Self-efficacy is a person’s perception of whether or not he or she would be capable of accomplishing a task (Bandura, 1986). Teachers who perceive that they have the ability to make their students learn, that is, they have a high self-efficacy to
teach, enhance student learning (Bandura, 1993). Science education in the
Australian primary school has suffered because of teachers’ low self-efficacy to
teach science and their reluctance to teach it (Appleton, 2002; Ginns & Watters,
1999; Skamp, 1991; Watters & Ginns, 2000).

The current study has been designed to examine the links between situational
interest, long-term individual interest, and self-efficacy to teach science. The
participants in the study are preservice primary teachers who are undertaking a
science content unit as part of their teacher preparation course.
Chapter 4
Research Methodology

4.1 Introduction

This chapter describes the methodology for investigating the research questions posed in the study.

1. Can situational interest be successfully aroused during a science content unit for primary teacher education students, and if so, how does this occur?
2. Can strategies designed to generate situational interest in science enhance preservice primary teachers’ long-term individual interest in science?
3. Can self-efficacy for teaching science be enhanced by use of strategies designed to arouse situational interest in science?

The study design is described in Section 4.2. In this section, construct and external validity of the study are considered, and the rationale for the use of quantitative and qualitative methods of data collection is presented. Additionally, details of the ethical practices for this study are provided. In Section 4.3 there is a description of the participants. The treatment is described in Section 4.4. Also in Section 4.4, the rationale for the choice of the science unit is explained. Section 4.4 continues with a description of the teaching techniques used to generate situational interest. Section 4.5 describes the quantitative and qualitative data collection methods. A summary of the chapter is presented in Section 4.6.
4.2 Study Design

This study used a group of participants who were involved in a pretest, a treatment, an immediate posttest, and a delayed posttest. McMillan and Schumacher (2010) define this type of study design as “preexperimental” because there is no comparison group, nor randomised assignment to groups. A preexperimental design is acceptable when it is the only option open to the researcher (Williamson, 2002). This was the case for this study because participants were tertiary students and it was not possible to interfere with their selection of lecture and tutorials.

Lennon-Dearing and Neely-Barnes (2012) argued that preexperimental designs “… have an important role in testing new intervention approaches, evaluating programs and generating theories” (p. 12). It is an appropriate design for use in the present study because one of its main aims was to test the effectiveness of interventions using strategies designed to arouse situational interest. The use of preexperimental designs is relatively common in educational research perhaps because these studies require access to established classes.

Many of the previous studies of situational interest in classrooms have used a similar design. For example, Rotgans and Schmidt (2011) conducted a one day, active-learning tutorial with 69 polytechnic students to investigate situational interest and its relationship with learning. The study was structured using a pretest to test concept recognition; the treatment comprised self-directed learning activities and collaborative learning in small groups; and a final posttest to determine student learning. Similarly, Randler and Bogner (2007) conducted research in a school ecology unit consisting of 14 lessons that involved 490 German secondary students.
The authors surveyed individual interest as a pretest, then the treatment consisted of the ecology unit, and a posttest was administered after the treatment. Other researchers such as Mitchell (1993), Mitchell and Gilson (1997), Harackiewicz et al. (2000), Chen and Darst (2002) have used similar designs.

Thus, a preexperimental design was appropriate for this study. Quantitative data were collected in a pretest that measured participants’ levels of individual interest for science and self-efficacy for teaching science. This was followed by the treatment during a science content unit in which activities designed to generate situational interest in science were initiated. On completion of the unit, an immediate posttest was administered to measure individual interest and self-efficacy. Ten months later, a delayed posttest repeated the measurement of individual interest and self-efficacy.

4.2.1 Potential threats to internal validity

There are disadvantages of the preexperimental design. McMillan and Schumacher (2010) point out that preexperimental designs have several potential threats to internal validity. They define internal validity as a “judgement that is made concerning the confidence with which plausible rival hypotheses can be ruled out as explanations for the results” (p. 264). It was important to be able to rule out other causes of changes to the dependent variables, that is, an individual interest for science and self-efficacy for teaching science. The main threats to internal validity identified by McMillan and Schumacher (2010) were a lack of a control group, attrition, subject effects, maturation, and pretesting. The ways in which these were identified and addressed in this study are described in this section.
The major disadvantage of a preexperimental design is that it does not have a control group for comparison to the treatment group. This makes it difficult to be certain if the cause of any change in the participants was the result of the treatment: “Without a comparison or control group, it is also difficult to know whether other factors occurring at the same time as the treatment were causally related to the dependent variable” (McMillan & Schumacher, 2010, p. 268). This problem was addressed in the current study by using interviews and questionnaires to explore causality. Students were directly asked what had caused any changes in their individual interest or self-efficacy.

Attrition is another threat to the internal validity of preexperimental designs. It occurs when subjects drop out or are lost during the investigation (McMillan & Schumacher, 2010). This has the potential to skew the results of a study because those students who drop out of a course, or who do not attend the lectures, may be those who are less capable or less interested than those who attend consistently. This was an important consideration for the present study because the delayed posttest was conducted ten months after the immediate posttest. Because the participants were asked to use identifiers, it was possible to track those students who had completed the pretest, immediate posttest, and the delayed posttest. The data from this group were compared to data of other participants to determine if there was any substantial difference in the responses.

Another type of threat to internal validity is subject effects. “Subject effects refer to subject changes in behaviour initiated by the subjects themselves in response to the research situation” (McMillan & Schumacher, 2010, p. 114). Participants
ideally should respond honestly when providing responses. However, participants may supply fake answers because they think that such answers may be “socially desirable responses or actions that will help or please the experimenter” (McMillan & Wergin, 2010, p. 62). A participant may want to appear a competent, intelligent student for the experimenter (McMillan & Schumacher, 2010). In the present study, participants completed surveys anonymously, though they did provide a name so their responses could be tracked across the three times of administration. In addition, the interviewer was not the researcher and was not involved in the science unit.

Maturation is another threat to internal validity. It is defined as “normal growth or changes in the participants of a study over time that affect the dependent variable” (McMillan & Schumacher, 2010, p. 113). For example, the participants may have become older, wiser, or developed greater self-efficacy over the course of the study (Creswell, 2008; McMillan & Schumacher, 2010). This is more of a concern when participants are young children who can go through significant maturational changes over relatively short periods of time. In the present study, by contrast, the participants were young adults.

Finally, pretesting can be considered a threat to the internal validity of preexperimental studies. McMillan and Schumacher (2010) explain that “taking a pretest could provide the subjects with motivation or practice on the types of questions asked or familiarize the subjects with the material tested” (p. 112). This could affect posttest data so that results may be due to the pretest and not the treatment. Again, this threat was addressed in the present study by using interview and questionnaires to ask students directly about the causes of any changes in their
individual interest or self-efficacy.

4.2.2 Construct validity of the study design

In the current study, it is hypothesised that a treatment will cause changes in the participants. According to McMillan and Schumacher (2010), construct validity is a judgement of “… how well measured variables and interventions represent the theoretical constructs that have been hypothesized (construct validity of the effects and causes, respectively)” (p. 265). The following threats to construct validity need to be managed to allow accurate inferences to be made.

Inadequate preoperational explication of the constructs

This threat is defined as a “failure to adequately define and explain the nature of the construct that is being investigated prior to the data collection” (McMillan & Schumacher, 2010, p. 115). Inadequate definitions of the independent and dependent variables may lead to inaccurate inferences from the results. Importantly, the constructs must be clearly described so that the study may be replicated by other researchers. In the present study, this description occurred in the literature review.

Mono-operation bias

This threat occurs when “only a single type of intervention or dependent variable is used when using multiple types would lead to more assurance that the more abstract theory is supported” (McMillan & Schumacher, 2010, p. 266). A lack of variety with a single manipulation of a treatment in a single place at a single point in time would result in limitations to inferences. In the current study, there were multiple and varied sources of activities designed to enhance situational interest.
There were two dependent variables, individual interest for science and self-efficacy for teaching science.

**Mono-method bias**

McMillan and Schumacher (2010) define this threat as “limitations based on a single way of measuring variables” (p. 116). This threat could be reduced by using several methods for measurement of the dependent variables. In this study, both quantitative and qualitative data were gathered for dependent variables of individual interest for science and self-efficacy for teaching science. These methods included surveys, written answers in open-ended questionnaires, and individual interviews. Triangulation of quantitative and qualitative data results was undertaken to provide meaningful inferences from the data.

4.2.3 **External validity**

McMillan and Schumacher (2010) defined external validity as the “extent to which the results of an experiment can be generalized to people and environmental conditions outside the context of the experiment” (p. 265). For the current study, the external validity would be the degree to which results of the treatment can be generalised to other participants or treatments. This study’s sample was a non-randomly selected group of voluntary participants. The intention was to generalise to similar groups of people, that is, Australian trainee primary teachers.

4.2.4 **Ethical considerations**

Researchers should not collect data from people at the expense of the rights and privacy of the people supplying the data. The following section describes the
ethical practices undertaken during the current study after permission to proceed was given by the Human Research Ethics Committee of the University of Newcastle.

Introduction of the study to potential participants

As lecturer and tutor in the science content unit used in the study, the researcher was not directly involved in the introduction of the study to potential participants or the data collection. The participants were contacted by a person not associated with the science content unit who provided them with an Information Statement about the study at the beginning of the science unit (Appendix A). Full disclosure of the purpose of the study was provided during the introduction. It was made clear orally and in the Information Statement that all participants were under no obligation to contribute to the study nor did they need to identify themselves if they volunteered. They could also withdraw from participation at any time without explanation.

Recruitment by implied consent

After potential participants were provided with information about the study, recruitment occurred as a result of implied consent: participants voluntarily completed the surveys. They were asked to return completed or uncompleted surveys to a collection box outside the tutorial room. Participants were not asked to put their own name on the survey. However, because data were to be gathered on three occasions, participants were asked to put a code name on the surveys, for example, their mother’s maiden name, so that the three surveys could be linked.
Confidentiality of the participants

Care was taken to safeguard the confidentiality of participants. No person was permitted to gain access to participants’ data except the researcher and supervisors. All collected data were securely stored. To ensure anonymity, participants used anonymous identifiers (their mother’s maiden name) for the surveys.

Recruitment of participants for individual interviews

At the end of the science unit when they completed the immediate posttest, participants were asked if they were willing to participate in an individual interview. Students who agreed to an interview were asked provide contact details to the interviewer who was not associated with the science unit. The interviewer then contacted the volunteers individually to arrange a time for the interview.

Ethical consideration of all nonparticipants in the science study

All resources and strategies designed to generate situational interest in the treatment were given to all tutors teaching in the science content unit. All preservice primary teachers received the same lectures. Thus, all preservice teachers enrolled in the unit would receive comparable treatment whether or not they participated in the study.

4.3 Participants

The study involved preservice primary teachers at a university campus located in New South Wales, Australia. These students were undertaking a four year Bachelor of Teaching/Bachelor of Arts degree in preparation for the profession of
primary school teacher. About 528 preservice primary teachers were enrolled in the compulsory science content unit in which the study was conducted. The science content unit provided students with scientific concepts they would need to teach science in the primary curriculum. At the time of the study, no other science related studies were being undertaken by the students. All participants who had agreed to take part in the study were those taught by the researcher, who was the lecturer for this science unit. Of the original group of 320 invited students, 313 students agreed to participate. They were members of the researcher’s twelve tutorial classes, and they also attended the lectures taught by the researcher. However, not all these students contributed to each of the data collections because some were absent for some sessions.

The large majority of students had studied science up to the completion of grade ten of high school. Science is mandatory in the New South Wales school curriculum to that level. A small number of students had undertaken senior science studies for the Year 12 Higher School Certificate, the final certification of high school education. The preservice teachers were mainly aged between 18-22 years, and most were female. The details of the participants are presented in Table 2.

Table 2

<table>
<thead>
<tr>
<th>Gender and Age of Participants (N= 313)</th>
<th>Frequency</th>
<th>Percentage of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>81</td>
<td>25.9</td>
</tr>
<tr>
<td>Female</td>
<td>232</td>
<td>74.1</td>
</tr>
<tr>
<td>18-22 age range</td>
<td>236</td>
<td>75.4</td>
</tr>
<tr>
<td>23-27 age range</td>
<td>42</td>
<td>13.4</td>
</tr>
<tr>
<td>28+ age</td>
<td>35</td>
<td>11.2</td>
</tr>
</tbody>
</table>
4.4 Treatment

The treatment of the study was incorporated into a science content unit within the primary teacher education program. The treatment consisted of frequent use of teaching strategies designed to arouse situational interest. This section presents a description of the science content unit, the rationale for selecting this unit for the study, the teacher’s dual role as teacher and researcher, and justification for the strategies used in an attempt to generate situational interest.

4.4.1 Description of the science content unit

The ten-week science content unit consisted of seven two-hour lectures and two one-hour lectures as well as ten one-hour weekly tutorials. The unit was specifically designed for primary teacher education students and was intended to develop their knowledge of science concepts. Table 3 shows the topics and the weeks in which they were presented during the semester.

<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Week</th>
<th>Topic</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Solar System</td>
<td>6</td>
<td>Ecology</td>
</tr>
<tr>
<td>2</td>
<td>Other Solar Systems and Space Travel</td>
<td>7</td>
<td>The Human Body</td>
</tr>
<tr>
<td>3</td>
<td>The Universe and its Energy</td>
<td>8</td>
<td>Cells and Genetics</td>
</tr>
<tr>
<td>4</td>
<td>Kinds of Energy</td>
<td>9</td>
<td>Natural Selection</td>
</tr>
<tr>
<td>5</td>
<td>Force, Work and Machines</td>
<td>10</td>
<td>The Earth</td>
</tr>
</tbody>
</table>

The lectures were carried out in a large theatre that could accommodate 500 students. The lectures typically contained explanations of science concepts with
examples from everyday life. There were pictures, diagrams, anecdotes, demonstrations, fun science facts, analogies, and the showing of relevant artefacts. These sessions typically used a transmission approach in which content was presented by the lecturer, and students sometimes asked questions, but there was generally a low level of interaction. The tutorial sessions were small groups of up to 26 students. They typically contained a high level of interaction as the students actively participated in activities and discussion. Most of the tutorial activities were designed to be relevant to primary schools. They used everyday materials that were easily obtained from home, the school, or the supermarket. This was important because a typical primary classroom would not have a science laboratory equipped with specialised science equipment.

4.4.2 Rationale for selecting science content unit

The science content unit had been designed by this researcher and was intended to be relevant to students who would be teaching science in primary schools. The researcher presented all the lectures and the 10 weekly tutorials that included the students who participated in the study. Some tutorials were taken by other tutors. These students were not invited to participate in the study because of the difficulty in ensuring they had comparable experiences. The researcher’s background was appropriate for the teaching of science concepts because she had worked for many years as a science teacher in secondary schools.

4.4.3 Sources of situational interest used in the treatment

The treatment comprised frequent use of teaching techniques designed to
enhance situational interest. These techniques had been previously identified in research as being sources of situational interest (see Chapter 3). The main sources incorporated into this treatment were novelty, personal relevance, physical activity, social interaction, and learning. There was some overlap in the activities that incorporated these sources, for example, an activity can incorporate novelty and social interaction or physical activity and learning.

Novelty

As noted in Chapter 3, it has been argued that an important source of situational interest is novelty (Chen et al., 1999; Dohn, 2011a; Durik & Harackiewicz, 2007; Hidi, 1990; Hidi & Renninger, 2006; Palmer, 2004b, 2009). In line with the research of Palmer (2004b), novelty is defined in this project as experiences that are new, unusual, unexpected, or surprising.

Personal relevance

Personal relevance is often referred to as meaningfulness. It is the value of the teaching techniques in meeting the students’ personal needs in real life or future career (Chen & Darst, 2002; Dohn et al., 2009; Mitchell, 1993; Nieswandt, 2007; Palmer, 2004b; Trend, 2005). In this treatment, relevance would result, for example, from teaching techniques being applicable to the participants’ future careers as teachers.

Physical activity

Physical activity is defined as physical participation in learning activities such as group work and individual discovery tasks in the classroom (Mitchell, 1993;
Palmer, 2009). Physical activity can involve social interaction as another source of situational interest described below.

**Social interaction**

Social interaction occurs when students liaise with fellow students in activities such as group work and discussion (Del Favero et al., 2007; Hidi & Renninger, 2006; Palmer, 2004). This social contact arouses situational interest from students as they communicate with one another about the task and information to be learned (Dohn, 2011).

**Learning**

Previous studies have indicated that situational interest enhances learning because it aids recall of information (Hidi, 1990; Hidi & Baird, 1986; Mitchell, 1993; O’Keefe & Linnenbrink-Garcia, 2014; Schraw et al., 2001; Wade, 2001). The relationship between learning and situational interest may be bi-directional. Palmer’s (2004b, 2009) studies found that successful learning experiences could generate situational interest amongst grade nine students and preservice primary teachers. Learning in this project is regarded as a source of situational interest if a participant reported gaining knowledge as the immediate result of exposure to a teaching technique.

These sources of situational interest were incorporated into the treatment using the following teaching techniques.

**4.4.4 Treatment techniques designed to enhance situational interest**

Each of the techniques described below was designed to utilise the sources of
situational interest.

**Hands-on activities**

In previous research, hands-on experiences in the classroom have been defined as activities in which students manipulate materials in practical or experimental tasks (Bergin, 1999; Dohn, 2011a; Mitchell, 1993; Nieswandt, 2007; Palmer, 2009). This study used hands-on science activities in each of the weekly tutorials. Many of these activities had unexpected or surprising outcomes, that is, they were novel activities. They also were relevant activities because they typically used everyday materials that would be appropriate for use in primary classrooms. As well, the activities allowed physical activity and social interaction as the students worked together to manipulate the materials. Finally, it was anticipated that these tasks would help participants to understand scientific concepts and thus give them a sense of success in learning.

One example of a hands-on group activity was the game using hypothetical natural selection of birds on an isolated island that ate the same available food. The birds had different beaks represented by pegs, spoons, chopsticks, and forks. The activity investigated which birds would be most successful in catching the food of beans. The aim was to test the beaks of the birds (manipulated by the trainee teachers) in a competition to obtain the most food in a certain period of time. The result could demonstrate the natural selection of a particular bird on the isolated island over a long period of time.

An individual hands-on activity involved the determination of the body’s pulse rate. Each participant constructed a simple pulse rate monitor made of a single straw inserted into a small lump of common, non-hazardous putty adhesive. The monitor
was stuck on the wrist area where the pulse is usually felt. The resulting back and forth movement of the straw, easily observed by the participant, reflected the pulse rate before and after exercise. Other hands-on activities and some associated worksheets can be found in Appendix I.

**Toys to demonstrate scientific concepts**

Tytler (2002) argued that toys could demonstrate a scientific concept, allowing teachers to take advantage of toys to promote students’ interest in science. In the present study, toys were used in most of the tutorials. The toys were able to provide novelty because they were unusual ways of presenting science concepts. They were also intended to provide relevance because many of the toys were simple, inexpensive examples of those owned or recognised by children, so they would be relevant to future use in primary classrooms. The toys also allowed physical activity and social interaction, as participants shared and discussed the toys with peers. The use of toys has not been reported as generating situational interest in science, but the researcher’s previous experiences in teaching suggested that this technique could generate situational interest.

One example of toy use involved an inexpensive solar grasshopper to demonstrate energy changes. When placed in direct sunlight, the light energy changed to electrical energy and then to the kinetic energy of a hopping grasshopper. A novel application of a common toy was the combination of a slinky with a foam cup placed in the top end of the suspended slinky. As the slinky bounced up and down to create longitudinal waves, it demonstrated the production of sound. The foam cup at the top amplified the vibrations creating sounds similar to the laser
weapons used in space movies. Some familiar toys used in the study to demonstrate scientific concepts can be seen in Appendix I.

**Science magic**

Kuhn, Amlani, and Rensink (2008) described science magic as mysterious and surprising because it is possible to demonstrate concepts of science that “are perceived as defying the laws of nature” (p. 349). In this study, science magic activities were only used in some tutorials and were intended to create surprise and unexpectedness. All the science magic activities were easy to perform and only required common materials from the school or home, so the participants would find them relevant to primary school teaching. Additionally, the science magic activities were designed to arouse situational interest from physical activity and social interaction during the participants’ personal exploration of the science magic. The use of science magic had not previously been reported as generating situational interest in science. This was another example of a technique that was included because the researcher’s experience of teaching led her to believe it might be successful.

One example of a science magic activity was the disappearing water in a cup. Some powder from a baby’s new disposable nappy (diaper) was hidden in an opaque cup. Not seen by the participants, the powder’s function was to absorb all water poured into the cup and create a clear gel. This resulted in the water appearing to have disappeared when the cup was turned upside down to “empty” the water into the sink. The activity explained the use of the maximum absorbency garment that astronauts wear during launch, re-entry, and spacewalks. Examples of science magic
activities and associated worksheets utilised in the tutorials are found in Appendix I.

**Demonstrations**

Demonstrations are instructional techniques usually conducted by the teacher. They may be intended to illustrate an experimental skill, visually aid a scientific concept, or to stimulate situational interest from a surprising result or real life connection (Nieswandt, 2007; Palmer, 2001). Demonstrations were used in every tutorial. Many were selected because they had a surprising or unexpected result in order to create novelty. They were intended to facilitate learning by showing a physical manifestation of a concept. They were also relevant for use in primary classrooms because they made use of everyday materials.

One example of a demonstration activity was the extraction of DNA from strawberries using materials available in most homes. This activity showed how simple it was to extract strawberry DNA, complemented by the unexpected and surprising result of being able to see and feel this abstract substance. The worksheet for this activity is located in Appendix I. Other examples of demonstrations utilised in the tutorials are found in Appendix I.

**Analogies**

Analogies are “mental models that students use to form limited but meaningful understandings of more complex concepts” (Paris & Glynn, 2004, p. 232). Participants can mentally visualise and understand a scientific concept by comparing it to something in everyday life that is similar and familiar (Treagust, Harrison, & Venville, 1996). In her research on analogies, Bennett-Clarke (2005) concluded that
“analogies in instruction can be a powerful and effective tool in promoting situational interest” (p. 188). Analogies were used in every lecture as a verbal or visual description to enhance learning. However, they were not used in every tutorial. On occasion, tutorials enabled participants to experience the physical modelling of analogies to describe scientific concepts. All examples of this technique aimed to arouse situational interest from the success of learning complex ideas. The tutorial analogies promoted physical activity and social interaction as the participants became engaged in the shared preparation of the analogies. The novelty of surprising and unexpected outcomes and personal relevance from science teaching ideas for the classroom were also intended to be sources of situational interest.

One example of an analogy was the task of modelling the Solar System with different sized fruit and vegetables. Another was the challenge of determining the distance of the Moon from Earth with scale-size balls and rope. Worksheets for these two tutorial activities can be found in Appendix I. A visual analogy used was an animation of 15 buses filled with hundreds and thousands, or cake sprinkles to represent 200 billion stars in a typical galaxy. Other examples of analogies for explaining science concepts are found in Appendix I.

**Fun science facts**

Fun science facts or science trivia refer to snippets of highly interesting information included in explanations that are related to the main ideas of the lesson (Palmer, 2004a). Fun facts were intended to be new, unusual, unexpected, or surprising. Therefore, they were a potential source of situational interest because they were novel.
Examples of fun facts about space travel included how the toilet operated in space aboard the space shuttle and International Space Station. During the lecture that included the achievements of ancient astronomers, it was mentioned that Tycho Brahe had an artificial nose fashioned from metal. This was the consequence of his nose being cut off in a sword duel. Examples of fun facts used in the lectures and tutorials are found in Appendix I.

**Anecdotes**

An anecdote or a short personal story can be a source of situational interest (Dohn, 2011b; Palmer, 2004b; Teichmann, 2008). According to Martin and Brouwer (1991), an anecdote could allow people to learn from everyday life. “Just a few well-chosen words could draw in a listener to create a world of shared experience” (p. 708). The anecdotes in this study were designed to create relevance by relating science concepts to real life experiences, and also to provide learning experiences as they demonstrated the real life applications of science concepts.

One example of a personal anecdote from the researcher’s experience was related to the fermentation process with alcohol as a product. I had become intoxicated as a young child after drinking home-made ginger beer. My parents had been unaware that alcohol was made in this simple process. The anecdote was designed to arouse situational interest from the novelty of unexpected information as well as from learning that home-made ginger beer was not safe for everyone. Examples of anecdotes to complement science concepts are found in Appendix I.

The teaching techniques described above were frequently used in the study, as shown in Table 4.
<table>
<thead>
<tr>
<th>Week</th>
<th>Topic</th>
<th>Sources of situational interest in lectures</th>
<th>Sources of situational interest in tutorials</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>The Solar System</td>
<td>Fun science facts</td>
<td>Hands-on activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analogies</td>
<td>Demonstrations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anecdotes</td>
<td>Toys</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fun facts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Analogies</td>
</tr>
<tr>
<td>2</td>
<td>Other Solar Systems and Space Travel</td>
<td>Fun science facts</td>
<td>Hands-on activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analogies</td>
<td>Science magic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anecdotes</td>
<td>Demonstrations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fun science facts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Analogies</td>
</tr>
<tr>
<td>3</td>
<td>The Universe and its Energy</td>
<td>Fun science facts</td>
<td>Hands-on activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analogies</td>
<td>Demonstrations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Toys</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fun science facts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Analogies</td>
</tr>
<tr>
<td>4</td>
<td>Kinds of Energy</td>
<td>Fun science facts</td>
<td>Hands-on activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analogies</td>
<td>Science magic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anecdotes</td>
<td>Demonstrations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Toys</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fun science facts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Analogies</td>
</tr>
<tr>
<td>5</td>
<td>Force, Work and Machines</td>
<td>Fun science facts</td>
<td>Hands-on activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analogies</td>
<td>Science magic</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anecdotes</td>
<td>Demonstrations</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Toys</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fun science facts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Analogies</td>
</tr>
<tr>
<td>6</td>
<td>Ecology</td>
<td>Fun science facts</td>
<td>Hands-on activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analogies</td>
<td>Demonstrations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anecdotes</td>
<td>Fun science facts</td>
</tr>
<tr>
<td>7</td>
<td>Cells and Genetics</td>
<td>Fun science facts</td>
<td>Hands-on activities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Analogies</td>
<td>Demonstrations</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Anecdotes</td>
<td>Toys</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fun science facts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Analogies</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Anecdotes</td>
</tr>
</tbody>
</table>
4.5 Data Collection

The study used mixed methods data collection comprising surveys, open-ended questionnaires, and interviews. These were implemented at three points in time: the beginning of the unit (the pretest), during the unit, at the end of the unit (the immediate posttest), and ten months after the end of the unit (delayed posttest). Data were collected on five occasions during the unit and two occasions after the unit.

Mixed methods data collection was chosen (Creswell, 2003). A mixed method approach has the potential to benefit from the strengths of both qualitative and quantitative methods of data collection (Wiersma & Jurs, 2009). McMillan and Schumacher (2010) also argued that “an important advantage of mixed-methods studies is that they can show the result (quantitative) and explain why it was obtained (qualitative)” (p. 25).
4.5.1 Quantitative data collection

This section describes the methods for collecting the study’s quantitative data. There were four surveys that were designed to measure the following: individual interest in science topics (Survey 1), individual interest in science (Survey 2), science teaching self-efficacy (Survey 3), and situational interest in science teaching techniques (Survey 4). The pretest comprised Surveys 1, 2, and 3. The same surveys were administered as an immediate posttest at the end of the science content unit and as the delayed posttest ten months later. Survey 4 was administered only once at the end of the science unit. The surveys are described below.

Survey 1: Individual interest in science topics

The purpose of Survey 1 was to measure individual interest in a set of science topics (Appendix C). The survey was developed specifically for this study. For construction of Survey 1, twenty common science topics were selected. Examples of topics were “The Universe”, “Earthquakes”, “Wildlife”, and “Weather”. The full list of items is presented in Table 5. The participants were asked to indicate their level of interest in learning a particular science topic by selecting one of the following Likert responses: “very uninterested” (1), “not interested” (2), “neutral” (3), “interested” (4), and “very interested” (5).
Table 5

*Topics Used in Survey 1*

<table>
<thead>
<tr>
<th>Science topics</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Universe</td>
</tr>
<tr>
<td>2. Chemical reactions</td>
</tr>
<tr>
<td>3. Volcanoes</td>
</tr>
<tr>
<td>4. Wildlife</td>
</tr>
<tr>
<td>5. Human body</td>
</tr>
<tr>
<td>6. Weather</td>
</tr>
<tr>
<td>7. Earthquakes</td>
</tr>
<tr>
<td>8. Marine science</td>
</tr>
<tr>
<td>9. Space exploration</td>
</tr>
<tr>
<td>10. Diseases</td>
</tr>
<tr>
<td>11. Fossils</td>
</tr>
<tr>
<td>12. Radioactivity</td>
</tr>
<tr>
<td>13. Inheritance</td>
</tr>
<tr>
<td>14. Chemicals</td>
</tr>
<tr>
<td>15. Rocks</td>
</tr>
<tr>
<td>16. Flight</td>
</tr>
<tr>
<td>17. Energy</td>
</tr>
<tr>
<td>18. Forensic Science</td>
</tr>
<tr>
<td>19. Dinosaurs</td>
</tr>
<tr>
<td>20. Invertebrate animals e.g., insects</td>
</tr>
</tbody>
</table>

The items in the list were chosen for the following reasons. During the science unit there would be a number of science topics taught to the students. It was anticipated that students could develop an interest in those topics but not necessarily in other topics in the wider realm of science. The items were chosen in the following way. Half of the items shown in Table 5 were scheduled to be taught in the unit and half were not. The items were arranged alternately, so the odd numbered items (for example, the universe, volcanoes, human body) were the ones explicitly taught in the unit, whereas the even numbered items (for example, chemical reactions, wildlife, weather) were not explicitly taught in the unit. The taught topics were referred to as List A, while the not-taught topics were referred to as List B.

Survey 1 was administered three times. The first occasion was the pretest (Time 1), during the first week of the science content unit. The second occasion was the immediate posttest (Time 2) which occurred 10 weeks later in the last week of the unit. The third occasion was the delayed posttest, which was carried out 10
months later (Time 3). Comparison of the pretest and immediate posttest would provide a measure of change in individual interest in science topics over the period of the science unit. Comparison of the delayed posttest with the immediate posttest would provide an indication of the extent to which any change in individual interest in science topics was maintained over time.

The survey was administered by a person not associated with the science unit. The surveys were handed to the participants at the beginning of their science tutorials, and they were given as much time as they needed to complete them. Participants were asked to write an anonymous identifier (their mother’s maiden name) on their survey to enable their responses from the three administrations of the surveys to be compared while maintaining participants’ anonymity. A collection box was provided for students to deposit their surveys upon completion. Those participants who did not wish to complete the survey also placed their survey in the box.

**Survey 2: Individual interest in science**

The purpose of Survey 2 was a second measure of individual interest in science (see Appendix D). Survey 2 was developed specifically for this study, and was designed to measure participants’ individual interest in science as indicated by their participation in science-related activities. According to Ainley and Ainley (2011), an individual interest in science would influence students’ behaviour by encouraging them to “enjoy participating in science activities and view science and science activities as personally important” (p. 54).

This survey consisted of 15 items. Examples of items were the following:
“I take an interest in science news”, “I watch science shows on television”, “I read articles about scientific discoveries”, and “I would like to study more science in the future”. The survey used a Likert-type scale that required a response of “never”, “rarely”, “sometimes”, “often”, and “very often”. These ratings were scored from one for “never” to five for “very often”.

**Survey 3: Science teaching efficacy beliefs**

The purpose of Survey 3, the “Science Teaching Efficacy Belief Instrument - B” (Appendix E), was to measure the science teaching self-efficacy of the preservice primary teachers. This instrument was developed by Enochs and Riggs (1990). It was selected because it had been widely used in other studies and had been shown to be a valid and reliable tool for measuring the self-efficacy to teach science of preservice primary teachers (Moseley & Utley, 2006).

The “Science Teaching Efficacy Belief Instrument” or “STEBI-B” contained 23 statements about teaching science. The survey contained two subscales: Personal Science Teaching Efficacy (PSTE) measured preservice teachers’ level of self-efficacy; while Science Teaching Outcome Expectancy (STOE) measured preservice teachers’ belief that students could learn science if they were taught effectively.

In the STEBI-B survey, two examples of items measuring PSTE were “Even if I try very hard, I will not teach science as well as I will most topics” and “I will not be very effective in monitoring science experiments”. Two items for STOE were “The inadequacy of a student’s science background can be overcome by good teaching” and “The teacher is generally responsible for the achievement of students in science”. The STEBI-B instrument used a five point Likert scale with choices
from “strongly agree” to “strongly disagree”. The items of each subscale in the STEBI-B were randomly placed throughout the instrument. The PSTE subscale had thirteen items (items 2, 3, 5, 6, 8, 12, 17, 18, 19, 20, 21, 22, 23) while the STOE subscale consisted of ten items (items 1, 4, 7, 9, 10, 11, 13, 14, 15, 16).

Some items in the instrument were positively worded while other items were negatively worded. The negative items were recoded for data analysis.

**Survey 4: Level of interest aroused by different teaching techniques**

The purpose of this survey was to determine the situational interest aroused in participants during the science unit as a result of the teaching techniques employed (Appendix H). It was completed once only at the end of the science unit as part of the immediate posttest (Time 2). The survey was developed for this study. It named the seven kinds of teaching techniques used in the science content and included some examples of activities for each of these techniques.

The participants were asked to indicate their level of interest in each kind of teaching technique used in the tutorials and lectures. The Likert scale for each of the kinds of teaching strategies in the survey ranged from one to five with “1” representing least interest to “5” representing the highest interest.

**4.5.2 Qualitative data collection**

This section describes the methods of qualitative data collection and analysis used in the study. The methods involved open-ended questionnaires administered on four occasions, and individual interviews. The qualitative data collection was to provide information about participants’ personal experiences during and after the
science unit. These data collection methods “allow the individual more freedom of response because certain feelings or information may be revealed that would not be forthcoming with selected response items” (Wiersma & Jurs, 2009, p. 204).

According to McMillan and Schumacher (2010), the validity of qualitative data can be enhanced by the use of a selected combination of any of the following strategies: multimethod data collection, participant language and verbatim accounts, low-inference descriptors, and mechanically recorded data (McMillan & Schumacher, 2010). The way in which these were used to establish validity in each of the qualitative data collection procedures was as follows. Multimethod strategies involve the use of several data collection techniques to allow for triangulation. The triangulation of qualitative techniques with other questionnaires, interviews and surveys is explained in the detailed sections below. This cross-validation would corroborate results, strengthen an understanding of the participants’ experiences, and support increased credibility of conclusions (McMillan & Schumacher, 2010).

A second technique to establish validity was the use of participant language and verbatim accounts, which involved the phrasing of questions in interviews and questionnaires in everyday language that the participants would understand. To this end, no questions contained abstract specialist language. For example, in the interviews, the word “interest” was used instead of “situational interest”, “personal interest” replaced the term “individual interest”, and “self-confidence to teach science” represented “self-efficacy to teach science”. From the responses in interviews and questionnaires, only verbatim accounts were used for data analysis.

The third technique to enhance validity was the use of low inference
descriptors when coding participants’ responses for data analysis. The participants’ words or phrases in their responses were as interpreted as literally as possible. This reduced the possibility that personal perceptions being made by the researcher could have an effect on patterns in the data and the final reporting (Seale, 1999). The final strategy to enhance validity was the use of mechanically recorded data. Audiotaping the interviews allowed an accurate record of the students’ responses.

Reliability was strengthened by a number of techniques. First, care was taken to ensure comparable conditions for the administration of each qualitative data method. Identical instructions were given to the participants by the same person who was not associated with the science unit. Second, the open-response questionnaire (Questionnaire 1) was administered to the participants on three occasions (Wiersma & Jurs, 2009). Comparability of data represented the third technique. This involved the triangulation of questionnaire and interview data with the quantitative data. As a fourth technique, all qualitative data collections required the use of unique anonymous identifiers (mother’s maiden name) to prevent the data from being linked to any individual. The final technique for reliability involved the coding of the questionnaires and interviews. Two people, the researcher and a colleague, independently coded the same data transcripts to establish reliability.

The methods of qualitative data collection used in this study are described below.

**Questionnaire 1: Evidence for situational interest in tutorials**

The purpose of this open-ended questionnaire was to establish whether or not situational interest did occur in selected tutorials in the science unit. The participants
were asked to write a short response to the question “Write down anything that interested you during the tutorial. Please explain as fully as you can” (Appendix F).

During the science unit, this questionnaire was administered at the end of tutorials in weeks four, seven, and nine. It was not possible to administer this questionnaire during lectures (even though teaching techniques designed to enhance situational interest in science were used during lectures) because many students attending the lectures were not participants in this study. A person not associated with the science unit handed out the questionnaires to the students during tutorials. A collection box was provided for students to deposit their surveys. Those students who did not wish to complete the survey also placed the survey in the same box.

Completed questionnaires were read, and coded with word labels that represented an interpretation of what each student had written. The coding categories were developed from the students’ responses and were intended to identify whether situational interest had occurred and its probable sources. The questionnaire asked students to write down anything that interested them in this tutorial. If a student wrote down an activity that had occurred in the tutorial then it was interpreted as an indication that situational interest had occurred, unless the response was clearly negative. The coding strategy described above was used to identify the sources of situational interest, and these were later grouped into themes to determine the main sources (Creswell, 2008; McMillan & Schumacher, 2010; Wiersma & Jurs, 2009). The themes were then cumulated by the number of times they appeared in the questionnaire data.

In order to enhance validity, the results of this questionnaire were triangulated
with the interview responses and Questionnaire 2 (described in the next section) to confirm whether situational interest had occurred, and its main sources. Validity was also enhanced by ensuring that the questions were constructed using participant language. Only actual words and phrases in the participants’ responses were used in data analysis. The reliability of the coding of these questionnaires was ensured by the researcher and a colleague independently coding thirty of the same data transcripts in each of the administrations from weeks four, seven, and nine.

**Questionnaire 2: Cause of changes in individual interest**

The purpose of this questionnaire was to determine causality of changes in reported individual interest. It was intended to identify why participants’ reported individual interest in science may have changed over the science unit (Appendix G). Questionnaire 2 was administered once only at the end of the science unit as part of the immediate posttest (Time 2). The questionnaire comprised two items. The first item comprised the question, “Has your interest in science changed while doing this science unit?”, and students were asked to circle either (A) “It has increased my interest in science”, or (B) “It has not changed my interest in science”, or “C” “It has decreased my interest in science”. The second item asked students to provide a written explanation of what caused any change in their interest in science. This questionnaire did not ask if self-efficacy to teach science had changed because the primary question of the study was individual interest. Data from interviews and surveys would show any changes in self-efficacy.

Validity of the questionnaire was established by triangulation with information from the interviews. Participant language and verbatim accounts were used in the
To enhance reliability, the questionnaire was administered by a person not associated with the science unit. The participants were given as much time as they needed to complete the questionnaire. Students were asked to use an anonymous identifier to enable their responses to be compared with their responses to other measures while maintaining anonymity. A collection box was provided near the door for students to deposit their questionnaires.

The responses to the statements about an increase (statement A), no change (statement B), or decrease (statement C) in individual interest in science since starting the science unit were counted. The responses to the question about what caused any change were read and coded using students’ actual words. Responses then were organised into themes. These themes were then quantified by the number of times they appeared in the written responses. The reliability of the coding of these questionnaires was ensured by two different people, the researcher and a colleague, independently coding thirty of the same data transcripts.

*Individual interviews*

Individual interviews were used because they permit the interviewer to repeat questions, explain the meaning of a question if not understood by the participant, ask probing questions to elicit information, and provide personal appreciation for the participant’s contribution (Burns, 2000; Charles & Mertler, 2002). Additionally, Burns (2000) argued that people are more willing to provide detailed oral answers to questions than to write responses to questions. Interviews therefore have the advantage of providing in-depth responses, as well as allowing participants to clarify
their meaning.

Individual interviews were carried out with 25 volunteer students. The interviews had several purposes: to confirm whether individual interest had changed (Questions 1, 2, 3, 4, 5, 6 below); to identify whether situational interest caused any changes in individual interest (Questions 7, 8, 9 below); to confirm whether self-efficacy had changed (Questions, 10, 11, 12, 13, 14 below); and to identify the causes in any changes in self-efficacy (Questions 15 and 16). The interviews were carried out over the two weeks immediately following the end of the science unit. The interviews typically lasted 30-40 minutes.

The interview questions were developed using a series of five pilot interviews. The results of the pilot interviews were not included in the results. The guiding questions for the interviews were:

1. Has the unit changed your interest in science?
2. Before the unit, what was your interest in science?
3. What is your interest in science after the unit?
4. On a scale of “negative, neutral, positive” what was your interest in science before the unit?
5. On a scale of “negative, neutral, positive” what is your interest in science after the unit?
6. Has there been any change in your behaviour with respect to science since you began the unit?
7. Was there anything that happened in the unit that helped increase your interest in science?
8. Did that interest you at the time?
9. Why did that interest you at the time?
10. Has the unit changed your confidence to teach science?
11. What was your confidence to teach science like before the unit?
12. What is your confidence to teach science like now after the unit?
13. On a scale of “positive, neutral and negative” before the unit what would your confidence to teach science have been?
14. On a scale of “positive, neutral and negative” after the unit, what would your confidence to teach science be now?
15. What happened in the unit that helped to make you more confident to teach science?
16. Did that help to increase your confidence in science?

To enhance the validity of the interview data, the questions were expressed in participants’ language with the participants’ responses being audiotaped. The recordings were transcribed verbatim, and then coded using low inference descriptors. The resulting data were triangulated with other qualitative data that collected evidence for sources of situational interest in the tutorials (Questionnaire 1) and causes of a change in interest (Questionnaire 2). Additionally, interview data were triangulated with the quantitative data about self-efficacy of preservice primary teachers to teach science.

To enhance reliability, analysis of the interview transcriptions was undertaken independently by two people, the researcher and a colleague. Coding was reviewed as the data collection and analysis progressed to support development of
emerging themes and to identify links to other data sources. In order to maintain confidentiality, all interviews were conducted by a person not involved in the science unit.

To analyse the interview data, the recordings were transcribed, coded, and categorised into themes that represented evidence for situational interest, evidence for changes in individual interest, evidence for changes in self-efficacy, and causes of these changes.

4.5.3 Schedule of Quantitative and Qualitative Data Collection

Table 6 provides the collection schedule for quantitative and qualitative data.

<table>
<thead>
<tr>
<th>Time</th>
<th>Instrument</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 1</td>
<td>Pretest comprising Surveys 1, 2, and 3 (to identify the level of prior individual interest for science and self-efficacy for teaching science)</td>
</tr>
<tr>
<td>Week 4</td>
<td>Questionnaire 1: (to establish situational interest)</td>
</tr>
<tr>
<td>Week 7</td>
<td>Questionnaire 1</td>
</tr>
<tr>
<td>Week 9</td>
<td>Questionnaire 1</td>
</tr>
<tr>
<td>Week 10</td>
<td>Survey 4: to determine level of situational interest aroused by different kinds of teaching techniques</td>
</tr>
<tr>
<td>End of unit</td>
<td>Immediate posttest comprising Surveys 1, 2, and 3 and questionnaire 2 (to identify the levels of individual interest for science and self-efficacy for teaching science after completing the science unit, changes in individual interest and causality of changes)</td>
</tr>
<tr>
<td>Up to two weeks after the unit</td>
<td>Individual interviews with 25 volunteer students</td>
</tr>
<tr>
<td>10 months after unit</td>
<td>Delayed posttest comprising Survey 1, 2, and 3 (to measure the extent to which changes in individual interest in science and self-efficacy for teaching science were stable over the long term)</td>
</tr>
</tbody>
</table>
4.6 Summary of Chapter 4

The methodology was chosen to address the research questions underpinning the study, which were as follows:

1. Can situational interest be successfully aroused during a science content unit for primary teacher education students, and if so, how does this occur?
2. Can strategies designed to generate situational interest in science enhance preservice primary teachers’ long-term individual interest in science?
3. Can self-efficacy for teaching science be enhanced by use of strategies designed to arouse situational interest in science?

The study had a pretest (Time 1), an intervention, an immediate posttest (Time 2), and a delayed posttest (Time 3) with mixed methods data collection. The participants were first year preservice primary teachers studying a compulsory science content unit as part of a four year Bachelor of Teaching/Bachelor of Arts degree. The pretest, immediate posttest, and delayed posttest measured participants’ reported individual interest for science and self-efficacy for teaching science. The delayed posttest was an important aspect of the data collection because both individual interest and self-efficacy are proposed to be relatively stable phenomena. The delayed posttest was necessary to establish that changes in these constructs were long-term in duration. The treatment was the science content unit, which was designed to generate situational interest in students on a regular basis.

Quantitative data were collected by four surveys (Surveys 1, 2, 3, and 4). Surveys 1 and 2 were designed for this study and measured individual interest in two different ways: by measuring interest in selected science topics, and by measuring
reported participation in science-related activities. Survey 3 measured science teaching self-efficacy using the STEBI-B instrument. Survey 4 was designed for this study and measured the level of situational interest generated by different kinds of teaching techniques used during the unit.

Qualitative data were collected in three ways. Questionnaire 1 asked students to identify situational interest in tutorials on three occasions during the semester. Questionnaire 2 asked students to identify if their individual interest in science had increased, decreased, or stayed the same during the science unit, and what factors had caused changes in individual interest. Individual interviews conducted after the science unit explored students’ experiences with individual interest in science and self-efficacy to teach science as the unit progressed.
Chapter 5
Quantitative Data Analyses

5.1 Introduction

Chapter 5 presents the results of surveys designed to determine if preservice primary teachers experienced an increase in individual interest for science as a result of the use of teaching techniques designed to arouse situational interest in science. The data analyses also were designed to determine if situational interest in science could enhance preservice science teachers’ self-efficacy to teach science. Participant information for each administration of the surveys is presented in Section 5.2. This is followed by the schedule of times for collecting quantitative data (Section 5.3). The measures and results for Survey 1 (individual interest in science topics, see Appendix C), Survey 2 (repeated measures analyses of variance of individual interest in science related activities, see Appendix D), Survey 3 (repeated measures analyses of variance of science teaching efficacy data, see Appendix E), and Survey 4 situational interest generated by teaching strategies during tutorials and lectures, see Appendix H) are presented in Section 5.4. An examination of correlations among results, across the surveys and across time, is described in Section 5.5. The chapter is summarised in Section 5.6.

A more robust research design for answering the research questions would have been an experimental design where one group of students (randomly assigned) would have received the “treatment” of a science unit replete with teaching techniques designed to enhance situational interest in science. A second group of
students (also randomly assigned) would participate in the same science unit, delivered by the same lecturer, but without the teaching techniques designed to enhance situational interest in science. If the treatment group then showed a significant increase in both situational interest in science and individual interest in science (compared with the non-treatment group), then it could be argued that enhanced situational interest in science acted as an impetus for enhanced individual interest in science. That is, there would be strong case for a causal chain of events.

However, it was not possible to conduct the current study using an experimental design. The science content unit was delivered in one semester. For ethical reasons, the researcher could not provide the nontreatment group of students with a series of lectures and tutorials devoid of interesting teaching activities. There was no opportunity for the nontreatment group to receive the teaching activities delivered to the treatment group at a later point in the education course. As such, the current research design cannot produce a strong case for causality from the quantitative data alone. However, the current design has produced a significant data set (from multiple sources and gathered in a longitudinal manner) from which reasonable conclusions can be drawn.

5.2 Participants

There were 313 participants in the pretest at the beginning of the science unit. There were 199 participants in the immediate posttest at the end of the science unit. At the third time for a delayed posttest, ten months after the science unit was completed, there were 136 participants. There were 104 participants who completed
the three surveys on the three occasions. The demographics details of these 104 participants are described below. Irrespective of time of administration, the preservice primary teachers who responded to the surveys were predominantly female and aged between 18 and 22 years.

**Demographic details of participants**

**Pretest participants (N = 313)**

The study began with 313 of the 320 students enrolled in the researcher’s tutorial classes (98% response rate). The pretest, containing three surveys, was administered just as the science unit began. See Table 7 for participant details. The surveys were titled “Interest in Science Topics” (Survey 1), “Personal Interest in Science” (Survey 2), and “Preservice Primary Science Teaching Efficacy Belief Instrument” (Survey 3).

Table 7

<table>
<thead>
<tr>
<th>Student information</th>
<th>Frequency</th>
<th>Percentage of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>78</td>
<td>24.9</td>
</tr>
<tr>
<td>Female</td>
<td>235</td>
<td>75.1</td>
</tr>
<tr>
<td>18-22 age range</td>
<td>237</td>
<td>75.7</td>
</tr>
<tr>
<td>23-27 age range</td>
<td>41</td>
<td>13.1</td>
</tr>
<tr>
<td>28+ age</td>
<td>35</td>
<td>11.2</td>
</tr>
</tbody>
</table>

As can be seen from Table 7, approximately 75% of the participants were female and aged between 18-22 years. Males represented 25% of the total participants at the pretest.
Immediate posttest participants (n = 199)

The same three surveys were administered to 199 of the original 313 students participating in the study (64% response rate) after ten weeks of the science unit. See Table 8 for details.

Table 8

Participants in the Immediate Posttest (n = 199)

<table>
<thead>
<tr>
<th>Student information</th>
<th>Frequency</th>
<th>Percentage of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>39</td>
<td>19.6</td>
</tr>
<tr>
<td>Female</td>
<td>160</td>
<td>80.4</td>
</tr>
<tr>
<td>18-22 age range</td>
<td>148</td>
<td>74.4</td>
</tr>
<tr>
<td>23-27 age range</td>
<td>26</td>
<td>13.1</td>
</tr>
<tr>
<td>28+ age</td>
<td>25</td>
<td>12.6</td>
</tr>
</tbody>
</table>

As can be seen from Table 8, approximately 80% of the participants were female. Those participants aged between 18-22 years represented a little over 74% of those responding to the immediate posttest surveys. Also, 20% were male and approximately 26% of participants were aged from 23 years to over 28 years.

Delayed posttest participants (n = 136)

Ten months after the immediate posttest, participants were requested to complete the three surveys again. Participants had not been exposed to any other science unit during this time. It was difficult to track down students who had participated in the science content unit because they had moved on to a variety of other courses. There were 136 participants of the original 313 students participating in the study (43% response rate). See Table 9 for details.
Table 9

Participants in the Delayed Posttest (n = 136)

<table>
<thead>
<tr>
<th>Student information</th>
<th>Frequency</th>
<th>Percentage of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>28</td>
<td>20.6</td>
</tr>
<tr>
<td>Female</td>
<td>108</td>
<td>79.4</td>
</tr>
<tr>
<td>18-22 age range</td>
<td>101</td>
<td>74.3</td>
</tr>
<tr>
<td>23-27 age range</td>
<td>14</td>
<td>10.3</td>
</tr>
<tr>
<td>28+ age</td>
<td>21</td>
<td>15.4</td>
</tr>
</tbody>
</table>

As can be seen from Table 9, approximately 79% of the participants were female and 21% were male. Those participants aged between 18-22 years represented approximately 74% of those responding to the delayed posttest. Also, 20% were male and 26% of participants were aged from 23 years to over 28 years.

Participants who completed Survey 1, Survey 2, and Survey 3 three times (n = 104)

Of particular interest were the 104 students who responded to the surveys in the pretest, the immediate posttest, and the delayed posttest. Note that some students did not complete all three surveys at all three times of administration. Hence, the number varies from 106 to 105 to 104 from Survey 1 to Survey 2 to Survey 3. Examination of this group of participants would enable a more clear-cut determination of any change in interest in science topics, individual interest in science, and self-efficacy to teach science across the three time points of the study. The demographic details of these participants are provided in Table 10.
Table 10

Participants Responding to All Surveys on All Three Occasions (n = 104)

<table>
<thead>
<tr>
<th>Student information</th>
<th>Frequency</th>
<th>Percentage of participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>19</td>
<td>18.3</td>
</tr>
<tr>
<td>Female</td>
<td>85</td>
<td>81.7</td>
</tr>
<tr>
<td>18-22 age range</td>
<td>80</td>
<td>76.9</td>
</tr>
<tr>
<td>23-27 age range</td>
<td>9</td>
<td>8.7</td>
</tr>
<tr>
<td>28+ age</td>
<td>15</td>
<td>14.4</td>
</tr>
</tbody>
</table>

The information from Table 10 indicates that there is little difference between these 104 participants and the other participants in the study, that is, most were female and the majority were aged between 18 and 22 years.

5.3 Collection of Data

Quantitative data were collected during tutorials. The surveys have been described in Chapter 4 and are described again briefly here. Survey 1 (Interest in Science Topics), Survey 2 (Personal Interest in Science), and Survey 3 (Preservice Primary Science Teaching Efficacy) were administered at three time points: (1) the pretest at the beginning of the science unit; (2) at the end of the ten week science unit; and (3) ten months after the science unit had been presented.

Survey 4 (Level of interest generated by teaching strategies during tutorials and lectures) was administered only once at the end of the science unit. The purpose of this survey was to determine the level of situational interest aroused in participants by different types of teaching techniques.
The surveys are reproduced in Appendices C, D, E, and H. The summary of times for data collection is presented in Table 11.

Table 11

<table>
<thead>
<tr>
<th>Survey</th>
<th>Pretest</th>
<th>Immediate posttest</th>
<th>Delayed posttest</th>
<th>Number of times offered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Survey 1</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>3</td>
</tr>
<tr>
<td>Survey 2</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>3</td>
</tr>
<tr>
<td>Survey 3</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>3</td>
</tr>
<tr>
<td>Survey 4</td>
<td>No</td>
<td>Yes</td>
<td>No</td>
<td>1</td>
</tr>
</tbody>
</table>

5.4 Measures and Results

Data were analysed using IBM SPSS Statistics version 21 software. The following information provides the methods of data analysis and results for Survey 1, Survey 2, and Survey 3 for all participants and then for those 104 participants who completed the surveys on three occasions. Survey 4 was offered only once at the end of the science unit. Participants did not identify themselves on Survey 4. Because of this, it was not possible to link Survey 4 results with the results of the other surveys.

5.4.1 Survey 1: Interest in science topics

The stem of the survey was: How interested are you in learning about the following? (see Appendix C). Participants were presented with 20 science topics (see Table 12). They responded using a Likert scale of “very uninterested” (1), “not interested” (2), “neutral” (3), “interested” (4), or “very interested” (5). The researcher taught 10 of the 20 topics on the list. The topics taught by the researcher are marked by an asterisk in Table 12.
Pretest results for all participants completing Survey 1 (N = 313)

Means and standard deviations (SD) for interest in each of the 20 science topics are presented in Table 12 (pretest statistics), Table 13 (immediate posttest statistics), and Table 14 (delayed posttest statistics).

Table 12

Interest in Science Topics at the Pretest Administration (N = 313)

<table>
<thead>
<tr>
<th>Science topics</th>
<th>Mean</th>
<th>SD</th>
<th>Science topics</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Universe*</td>
<td>3.67</td>
<td>0.87</td>
<td>11. Fossils*</td>
<td>2.82</td>
<td>0.96</td>
</tr>
<tr>
<td>2. Chemical reactions</td>
<td>2.93</td>
<td>0.97</td>
<td>12. Radioactivity</td>
<td>2.71</td>
<td>0.90</td>
</tr>
<tr>
<td>3. Volcanoes*</td>
<td>3.42</td>
<td>0.82</td>
<td>13. Inheritance*</td>
<td>3.26</td>
<td>1.00</td>
</tr>
<tr>
<td>4. Wildlife</td>
<td>3.69</td>
<td>0.92</td>
<td>14. Chemicals</td>
<td>2.66</td>
<td>0.94</td>
</tr>
<tr>
<td>5. Human body*</td>
<td>3.92</td>
<td>0.93</td>
<td>15. Rocks*</td>
<td>2.44</td>
<td>0.89</td>
</tr>
<tr>
<td>6. Weather</td>
<td>3.41</td>
<td>0.91</td>
<td>16. Flight</td>
<td>3.00</td>
<td>0.93</td>
</tr>
<tr>
<td>7. Earthquakes*</td>
<td>3.25</td>
<td>0.85</td>
<td>17. Energy*</td>
<td>2.98</td>
<td>0.89</td>
</tr>
<tr>
<td>8. Marine science</td>
<td>3.47</td>
<td>1.00</td>
<td>18. Forensic Science</td>
<td>3.68</td>
<td>1.06</td>
</tr>
<tr>
<td>9. Space exploration*</td>
<td>3.37</td>
<td>0.99</td>
<td>19. Dinosaurs*</td>
<td>2.27</td>
<td>1.08</td>
</tr>
<tr>
<td>10. Diseases</td>
<td>3.42</td>
<td>1.06</td>
<td>20. Invertebrate animals</td>
<td>2.83</td>
<td>0.99</td>
</tr>
</tbody>
</table>

* Topics taught by the researcher

Table 13

Interest in Science Topics at the Immediate Posttest Administration (n = 199)

<table>
<thead>
<tr>
<th>Science topics</th>
<th>Mean</th>
<th>SD</th>
<th>Science topics</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Universe*</td>
<td>4.34</td>
<td>.62</td>
<td>11. Fossils*</td>
<td>3.67</td>
<td>0.89</td>
</tr>
<tr>
<td>2. Chemical</td>
<td>3.60</td>
<td>.92</td>
<td>12. Radioactivity</td>
<td>3.39</td>
<td>0.86</td>
</tr>
<tr>
<td>3. Volcanoes*</td>
<td>4.09</td>
<td>.67</td>
<td>13. Inheritance*</td>
<td>4.15</td>
<td>0.77</td>
</tr>
<tr>
<td>4. Wildlife</td>
<td>4.20</td>
<td>.77</td>
<td>14. Chemicals</td>
<td>3.35</td>
<td>0.87</td>
</tr>
<tr>
<td>5. Human body*</td>
<td>4.37</td>
<td>.72</td>
<td>15. Rocks*</td>
<td>3.41</td>
<td>0.95</td>
</tr>
<tr>
<td>6. Weather</td>
<td>3.87</td>
<td>.85</td>
<td>16. Flight</td>
<td>3.75</td>
<td>0.82</td>
</tr>
<tr>
<td>7. Earthquakes*</td>
<td>3.96</td>
<td>.71</td>
<td>17. Energy*</td>
<td>3.78</td>
<td>0.78</td>
</tr>
<tr>
<td>8. Marine science</td>
<td>4.05</td>
<td>.82</td>
<td>18. Forensic Science</td>
<td>4.36</td>
<td>0.72</td>
</tr>
<tr>
<td>9. Space</td>
<td>4.33</td>
<td>.68</td>
<td>19. Dinosaurs*</td>
<td>4.10</td>
<td>0.74</td>
</tr>
<tr>
<td>10. Diseases</td>
<td>4.08</td>
<td>.70</td>
<td>20. Invertebrate animals</td>
<td>3.67</td>
<td>0.86</td>
</tr>
</tbody>
</table>

* Topics taught by the researcher
Table 14

*Interest in Science Topics at the Delayed Posttest Administration (n = 136)*

<table>
<thead>
<tr>
<th>Science topics</th>
<th>Mean</th>
<th>SD</th>
<th>Science topics</th>
<th>Mean</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Universe*</td>
<td>4.06</td>
<td>.67</td>
<td>11. Fossils*</td>
<td>3.66</td>
<td>.82</td>
</tr>
<tr>
<td>2. Chemical reactions</td>
<td>3.50</td>
<td>.90</td>
<td>12. Radioactivity</td>
<td>3.18</td>
<td>.91</td>
</tr>
<tr>
<td>3. Volcanoes*</td>
<td>4.02</td>
<td>.60</td>
<td>13. Inheritance*</td>
<td>4.01</td>
<td>.84</td>
</tr>
<tr>
<td>5. Human body*</td>
<td>4.23</td>
<td>.69</td>
<td>15. Rocks*</td>
<td>3.15</td>
<td>.82</td>
</tr>
<tr>
<td>6. Weather</td>
<td>3.66</td>
<td>.83</td>
<td>16. Flight</td>
<td>3.44</td>
<td>.82</td>
</tr>
<tr>
<td>7. Earthquakes*</td>
<td>3.97</td>
<td>.67</td>
<td>17. Energy*</td>
<td>3.45</td>
<td>.79</td>
</tr>
<tr>
<td>8. Marine science</td>
<td>3.89</td>
<td>.82</td>
<td>18. Forensic Science</td>
<td>4.06</td>
<td>.86</td>
</tr>
<tr>
<td>10. Diseases</td>
<td>3.59</td>
<td>.85</td>
<td>20. Invertebrate animals</td>
<td>3.49</td>
<td>.95</td>
</tr>
</tbody>
</table>

* Topics taught by the researcher

Figure 1 provides a visual display of students’ interest in the 20 science topics across the three administrations of the survey.

![Figure 1: Mean scores for interest in the 20 science topics across three administrations of Survey 1](image_url)

*Figure 1:* This figure shows individual interest in each of the 20 science topics (numbered 1 to 20) at the pretest, the immediate posttest, and of the delayed posttest.
As can be seen in Figure 1, participants’ individual interest in all science topics rose from the pretest to the immediate posttest at the completion of the science content unit. The level of individual interest remained much higher in the delayed posttest than in the pretest though there was a drop in interest for most of the topics.

Because the researcher taught 10 of the 20 science topics in the science unit, it was useful to compare topics she taught with topics she did not teach. Would students indicate more interest in the topics the researcher taught compared with the topics she did not teach? To compare students’ interest in topics taught versus topics not taught, two quasiscales were formed: Interest in Science Topics List A (taught by the researcher) and Interest in Science Topics List B (not taught by the researcher). It is important to note that these were not scales in the sense that they were not designed to measure an underlying construct other than reported interest in science topics. Treating them as quasiscales, Cronbach’s alphas, means, and standard deviations were calculated (see Table 15).

Table 15

<table>
<thead>
<tr>
<th>Survey 1 Administration</th>
<th>Cronbach’s alpha</th>
<th>Number</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest A</td>
<td>0.75</td>
<td>313</td>
<td>32.40</td>
<td>5.17</td>
</tr>
<tr>
<td>Pretest B</td>
<td>0.73</td>
<td>313</td>
<td>31.70</td>
<td>5.21</td>
</tr>
<tr>
<td>Immediate posttest A</td>
<td>0.75</td>
<td>199</td>
<td>40.18</td>
<td>4.24</td>
</tr>
<tr>
<td>Immediate posttest B</td>
<td>0.75</td>
<td>199</td>
<td>38.29</td>
<td>4.53</td>
</tr>
<tr>
<td>Delayed posttest A</td>
<td>0.72</td>
<td>136</td>
<td>38.18</td>
<td>4.02</td>
</tr>
<tr>
<td>Delayed posttest B</td>
<td>0.71</td>
<td>136</td>
<td>36.03</td>
<td>4.50</td>
</tr>
</tbody>
</table>
Dependent measures t-tests comparing Interest in Science Topics List A and Interest in Science Topics List B for the three times of administration were conducted to look for differences between students’ interest in topics taught by the researcher and topics not taught by the researcher. There were differences between List A and List B at the pretest ($t = 2.89, p < .01$), the immediate posttest ($t = 8.16, p < .001$), and at the delayed posttest ($t = 6.50, p < .001$). At each administration of the Survey, students indicated more interest in the topics on List A than the topics on List B.

It should be noted that there was a significant difference between interest in List A and List B topics at the pretest, though the difference was not strong. This was an unexpected finding. The researcher did not deliberately select the science topics she taught and did not teach based on her perception of topics that students would find more or less interesting. It was anticipated there would be no difference between the lists at the pretest. It is noteworthy, however, that the difference between students’ interest in the two sets of science topics was highly significant at the time of the immediate posttest and the delayed posttest.

To investigate changes over time, a repeated measures analysis of variance (ANOVA) was conducted on both Interest in Science Topics List A and Interest in Science Topics List B. The data for the 106 students who completed both quasiscales on the three times of administration are shown in Table 16.
For Interest in Science Topics List A, a one-way repeated measures ANOVA was conducted using a Greenhouse-Geisser correction because Mauchly’s test of sphericity showed that common variance in scores across the three time points could not be assumed. It was determined that the results of Interest in Science Topics List A differed significantly between the time points, $F(1.66, 174.35) = 119.15, p < .001$.

Post hoc t-tests revealed that Interest in Science Topics List A rose significantly from the pretest to the immediate posttest ($t = 13.34, p < .001$). Individual interest in science topics fell significantly from the immediate posttest to the delayed posttest ($t = -3.61, p < .001$). However, Interest in Science Topics List A rose significantly from the pretest to the delayed posttest ($t = 10.26, p < .001$).

For Interest in Science Topics List B, a one-way repeated measures ANOVA was conducted using a Greenhouse-Geisser correction because Mauchly’s test of sphericity showed that common variance in scores across the three time points could not be assumed. It was determined that the results of Interest in Science Topics List B across
B differed significantly between the time points, \( F(1.69, 176.94) = 63.40, p < .001 \).

Post hoc t-tests revealed that Interest in Science Topics List B rose significantly from the pretest to the immediate posttest (\( t = 10.43, p < .001 \)). Individual interest in the science topics fell significantly from the immediate posttest to the delayed posttest (\( t = -4.44, p < .001 \)). However, Interest in Science Topics List B rose significantly from the pretest to the delayed posttest (\( t = 6.53, p < .001 \)).

To summarise the results for Survey 1, Interest in Science Topics, the 20 science topics were divided into two lists, List A and List B, on the basis of whether or not the researcher taught the topic during the science unit. For both List A and List B, there was a significant increase in interest in topics from the pretest to the immediate posttest. Interest in both List A and List B fell from the immediate posttest to the delayed posttest. However, interest in both List A and List B remained significantly higher at the delayed posttest than at the pretest.

Even though the topics in List B were not taught by the researcher, students’ interest in them rose from the pretest to the immediate posttest, in a similar manner to students’ interest in the topics in List A, the ones taught by the researcher. There appears to have been general lift in interest in science topics for those taught and not taught during the science unit.

5.4.2 Survey 2: Individual interest in science

Survey 2 was designed to assess students’ individual interest in science. This survey was titled “Personal Interest in Science” (see Appendix D). The survey used a Likert-type scale that required a response of “never” (1), “rarely” (2), “sometimes” (3), “often” (4), and “very often” (5).
Fifteen items were generated by the researcher for Survey 2. A principal components factor analysis was conducted to refine the scale for final use (reproduced in Appendix J). Once the scale was formed, a one-way repeated measures analysis of variance was performed for the three times the survey was administered.

**Factor analysis of items in Survey 2**

Survey 2 (reproduced in Appendix D) contained 15 items about individual interest in science. Given time constraints, it was not possible to conduct a pilot test of the items. A factor analysis was conducted on the pretest data for the survey. There were 313 students who completed Survey 2. Using SPSS version 21 software, a Principal Components factor analysis was conducted. This is reproduced in Appendix J. Two factors emerged, the first accounting for 43.89% of the variance and the second factor accounting for 7.78% of the variance.

The decision was made to retain the items that loaded above 0.4 on the first factor and below 0.3 on the second factor. Using this selection procedure, 11 items were retained in the scale: Items 1, 2, 3, 4, 5, 6, 8, 9, 10, 12 and 15. They are shown in Table 16. Four items were removed from the scale: Items 7, 11, 13 and 14 (“I listen to shows about science on the radio”; “I like doing science-related activities”; “I am interested in what scientists do”; and “I am interested in how scientists make discoveries”).

The internal reliability of Survey 2 was then assessed using the Cronbach’s alpha on 11 items. The Cronbach’s alpha for the pretest administration was 0.89 ($N = 313$), for the immediate posttest was 0.87 ($n = 199$), and for the delayed posttest
was 0.87 ($n = 136$).

Descriptive statistics for each item of Survey 2 for the pretest administration are shown in Table 17.

Table 17

*Pretest Results for Individual Interest in Science ($N = 313$)*

<table>
<thead>
<tr>
<th>Individual interest in science</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I take an interest in science news.</td>
<td>2.52</td>
<td>0.79</td>
</tr>
<tr>
<td>2. I read articles about scientific discoveries.</td>
<td>2.19</td>
<td>0.84</td>
</tr>
<tr>
<td>3. I like to understand scientific ideas.</td>
<td>2.87</td>
<td>0.89</td>
</tr>
<tr>
<td>4. I talk about science with friends.</td>
<td>2.04</td>
<td>0.89</td>
</tr>
<tr>
<td>5. I discuss things I learn about science with my family.</td>
<td>2.69</td>
<td>1.01</td>
</tr>
<tr>
<td>6. I watch science shows on television.</td>
<td>2.54</td>
<td>0.92</td>
</tr>
<tr>
<td>8. I look up information about science on the web.</td>
<td>2.09</td>
<td>0.90</td>
</tr>
<tr>
<td>9. I would like to study more science in the future.</td>
<td>2.63</td>
<td>0.94</td>
</tr>
<tr>
<td>10. I like to find out about science related issues.</td>
<td>2.50</td>
<td>0.84</td>
</tr>
<tr>
<td>12. I like to think about science problems.</td>
<td>1.92</td>
<td>0.84</td>
</tr>
<tr>
<td>15. I would be interested in learning more science than my degree program requires.</td>
<td>2.37</td>
<td>1.03</td>
</tr>
</tbody>
</table>

*Repeated measures analysis of variance*

A repeated measures analysis of variance was conducted across the three times students responded to Survey 2: before the science unit began (pretest); immediately at the finish of the science unit (immediate posttest); and ten months after the immediate posttest (delayed posttest). There were 105 students who completed Survey 2 on the three occasions and their data were used in the analysis. Means and standard deviations for the scale at the three times it was administered are shown in Table 18, both for the 105 students who completed the scale on three occasions, and for the other students who completed the scale on one or two occasions.
A one-way repeated measures ANOVA was conducted using a Greenhouse-Geisser correction because Mauchly’s test of sphericity showed that common variance in scores across the three time points could not be assumed. It was determined that the results of Survey 2 (Personal Interest in Science) differed significantly between the time points, \( F(1.57, 163.5) = 98.25, p < .001 \).

Post hoc t-tests revealed that individual interest in science rose significantly from the pretest (\( M = 27.07, SD = 6.90 \)) to the immediate posttest (\( M = 36.61, SD = 5.52 \)), \( t = 12.98, p < .001 \). Individual interest in science fell significantly from the immediate posttest (\( M = 36.61, SD = 5.52 \)) to the delayed posttest (\( M = 33.55, SD = 5.90 \)), \( t = -6.21, p < .001 \). However, individual interest in science remained significantly higher in the delayed posttest than in the pretest (\( t = 7.94, p < .001 \)).

To recap, the analyses show that individual interest in science rose markedly from the beginning of the semester to the end of the semester in which students undertook the science unit. While individual interest in science fell from the end of the science unit to the third time of testing, ten months later, it remained significantly higher than it had been at the first time of testing.

Though the results show a decrease in individual interest in science from the immediate posttest to the delayed posttest, the decrease was significantly less than the increase in individual interest in science from pretest to immediate posttest. It was important to demonstrate that the results for the 105 students who completed Survey 2 on the three occasions were no different from the results for the students who completed the survey on one or two occasions only. Perhaps the 105 students were more diligent students and therefore were more likely to be interested in science.
activities? To do this, independent t-tests were conducted on the three occasions, comparing the 105 students to the other students. This information is presented in Table 18.

Table 18

*Comparing Interest in Science Responses for the 105 Students and the Other Students Who Completed the Survey*

<table>
<thead>
<tr>
<th>Survey completions</th>
<th>N</th>
<th>M</th>
<th>SD</th>
<th>t</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pair 1 Pretest: n = 105</td>
<td>105</td>
<td>27.07</td>
<td>6.90</td>
<td>1.32</td>
<td>Nonsignificant</td>
</tr>
<tr>
<td>Pretest: Other</td>
<td>208</td>
<td>25.90</td>
<td>6.82</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 2. Immediate posttest: n = 105</td>
<td>105</td>
<td>36.61</td>
<td>5.52</td>
<td>0.15</td>
<td>Nonsignificant</td>
</tr>
<tr>
<td>Immediate posttest: Other</td>
<td>94</td>
<td>36.48</td>
<td>6.10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair 3. Delayed posttest: n = 105</td>
<td>105</td>
<td>33.55</td>
<td>5.90</td>
<td>1.91</td>
<td>Nonsignificant</td>
</tr>
<tr>
<td>Delayed posttest: Other</td>
<td>31</td>
<td>31.29</td>
<td>5.47</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

There were no significant differences between the students who completed Survey 2 on three occasions and the other students who had completed the survey one or two times.

5.4.3 Survey 3: Science Teaching Efficacy Belief Instrument (STEBI-B)

The purpose of Survey 3, the Science Teaching Efficacy Belief Instrument-B or “STEBI-B (see Appendix E), was to measure the science teaching self-efficacy of the preservice primary teachers. As described in Chapter 4, the 23-item survey contained two subscales which were analysed separately, the Personal Science Teaching Efficacy (PSTE) and Science Teaching Outcome Expectancy (STOE). The
results are presented below.

Both PSTE and STOE subscales were tested for internal consistency. A factor analysis was undertaken for both subscales using a Principal Components method. The PSTE scale did not need refining to improve internal consistency. However, the STOE subscale did require item reduction for reliability improvement by the removal of items 10 and 13. The Cronbach’s alpha coefficients of reliability of the PSTE scale for the pretest, immediate posttest, and the delayed posttest were 0.80, 0.82, and 0.83 respectively. The Cronbach’s alpha coefficients of the STOE scale for the pretest, immediate posttest, and the delayed posttest were 0.70, 0.73, and 0.72 respectively. As such, the PSTE was a more robust scale than the STOE.

**Personal science teaching efficacy (PSTE) subscale results**

To determine if any statistically significant differences existed between the three results of Survey 3 PSTE subscales of the STEBI-B instrument for participants who completed all three surveys ($n = 104$), a one-way repeated measures analysis of variance was performed for PSTE and STOE separately. Post hoc tests using Bonferroni adjustments enabled determination of which survey periods were significantly different from each other.

**Descriptive statistics for personal science teaching efficacy (PSTE)**

The descriptive statistics for the PSTE scales for participants ($n = 104$) appear in Table 19.
Table 19

**Descriptive Statistics for the PSTE Results (13 items)**

<table>
<thead>
<tr>
<th>PSTE results</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest ((n = 104))</td>
<td>43.50</td>
<td>5.61</td>
</tr>
<tr>
<td>Immediate posttest ((n = 104))</td>
<td>48.81</td>
<td>6.20</td>
</tr>
<tr>
<td>Delayed posttest ((n = 104))</td>
<td>47.59</td>
<td>5.99</td>
</tr>
</tbody>
</table>

As can be seen in Table 19, the mean of the PSTE results of each Survey 3 administration increased from the pretest to the immediate posttest. The delayed posttest was also higher than the pretest. To determine any statistically significant differences between each survey time period, post hoc pairwise comparisons were made.

*Post hoc pairwise comparisons of PSTE results for participants \((n = 104)\)*

From the results of one-way repeated measures analysis of variance, Mauchly’s test of sphericity was found to be nonsignificant and, therefore, sphericity was assumed: \(\chi^2(2) = 1.15, p = .564\). Using the “Sphericity Assumed” values, the \(F\) value was determined to be \(F(2, 206) = 36.13, p = .000\) with a medium effect size of \(\varepsilon = .39\).

The following post hoc pairwise comparisons in Table 20 were made for the personal science teaching efficacy belief scale (PSTE) across the three administrations for \(n = 104\) participants.
Table 20

Post Hoc Pairwise Comparisons of the PSTE Subscale for Participants (n = 104)

<table>
<thead>
<tr>
<th>Pairwise comparisons (n = 104)</th>
<th>Mean difference</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest-Immediate posttest</td>
<td>5.31</td>
<td>.000</td>
</tr>
<tr>
<td>Immediate posttest-Delayed posttest</td>
<td>1.22</td>
<td>ns</td>
</tr>
<tr>
<td>Pretest-Delayed posttest</td>
<td>4.09</td>
<td>.000</td>
</tr>
</tbody>
</table>

The post hoc pairwise comparisons of the PSTE results show that there were significant increases for personal science teaching efficacy (PSTE) from the pretest to the immediate posttest and from the pretest to the delayed posttest for participants (n = 104). However, there was no significant difference in the results from the immediate posttest to the delayed posttest. The results show that the participants maintained their heightened personal science teaching efficacy beliefs from the immediate posttest to the delayed posttest.

Science teaching outcome expectancy (STOE) subscale results

From one-way repeated measures analysis of variance, Mauchly’s test of sphericity was not statistically significant and, therefore, sphericity had been assumed: $\chi^2(2) = 3.16, p = .206$ with a small effect size of $\varepsilon = .14$. Using the “Sphericity Assumed” values, the $F$ value was determined to be $F(2, 206) = 17.30, p = .000$.

Descriptive statistics for science teaching outcome expectancy (STOE)

The descriptive statistics for the STOE scales for participants (n = 104) appear in Table 21.
Table 21

*Descriptive Statistics for the STOE Results (8 items) n = 104*

<table>
<thead>
<tr>
<th>STOE results</th>
<th>Mean</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest</td>
<td>28.90</td>
<td>3.77</td>
</tr>
<tr>
<td>Immediate posttest</td>
<td>31.12</td>
<td>3.28</td>
</tr>
<tr>
<td>Delayed posttest</td>
<td>30.97</td>
<td>3.43</td>
</tr>
</tbody>
</table>

*Post hoc pairwise comparisons of STOE results (n = 104)*

Post hoc pairwise comparisons from one-way repeated measures ANOVA determined any statistically significant differences in science teaching outcome expectancy (STOE) between the three different survey administrations. This relevant information for comparisons is presented in Table 22.

Table 22

*Post Hoc Pairwise Comparisons of the STOE Subscale for Participants (n = 104)*

<table>
<thead>
<tr>
<th>Paired comparisons</th>
<th>STOE</th>
<th>Mean difference</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest-Immediate posttest</td>
<td>2.21</td>
<td>.000</td>
<td></td>
</tr>
<tr>
<td>Immediate posttest-Delayed posttest</td>
<td>0.14</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>Pretest-Delayed posttest</td>
<td>2.07</td>
<td>.000</td>
<td></td>
</tr>
</tbody>
</table>

From the post hoc pairwise comparisons, it was evident that there were statistically significant differences for the STOE results from the pretest to the immediate posttest, and the pretest to the delayed posttest for all participants. Similar to the PSTE results, the STOE results for the immediate posttest to the delayed posttest revealed a statistically nonsignificant difference in means. In comparison to
the PSTE results, the change in STOE was not as notable as the change in PSTE results.

5.4.4 Survey 4: Interest aroused by different teaching techniques

The intention of this survey was to determine the level of situational interest in the participants \( n = 243 \) during the science unit as a result of different kinds of teaching techniques used in the study. The survey was titled *Level of interest generated by teaching strategies during tutorials and lectures* (see Appendix H). It was completed once only at the end of the science content unit. The survey was developed by the researcher. It identified seven kinds of teaching techniques and tutorial activities that were designed to arouse situational interest in science (see Table 23).

The participants were asked to indicate their level of interest in each type of technique used in the tutorials and lectures. The Likert scale ranged from one to five with “1” representing least interest to “5” representing highest interest. In Survey 4 (produced in Appendix H), examples of each of these techniques were included to remind students of what had occurred during the semester. This was important because the seven kinds of teaching techniques had not been identified for the participants prior to or during the treatment, nor was each activity explicitly described as a specific technique. It also would have been difficult to treat these kinds of activities as independent of each other. For example, toys could be used in hands-on activities. Analogies, too, could involve hands-on activities. Science magic could be part of a demonstration.

The descriptive statistics are presented in Table 23.
Table 23

*Descriptive Statistics for Interest Aroused by Teaching Techniques (n = 243)*

<table>
<thead>
<tr>
<th>Teaching technique</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hands-on activities</td>
<td>4.40</td>
<td>0.79</td>
</tr>
<tr>
<td>Science magic</td>
<td>4.34</td>
<td>0.75</td>
</tr>
<tr>
<td>Demonstrations</td>
<td>4.31</td>
<td>0.83</td>
</tr>
<tr>
<td>Anecdotes</td>
<td>4.25</td>
<td>0.83</td>
</tr>
<tr>
<td>Use of toys</td>
<td>4.21</td>
<td>0.81</td>
</tr>
<tr>
<td>Analogies</td>
<td>4.10</td>
<td>0.83</td>
</tr>
<tr>
<td>Fun facts</td>
<td>3.71</td>
<td>0.97</td>
</tr>
</tbody>
</table>

From the information in Table 23, six of the seven techniques were rated above 4.0 on a five point scale. The teaching techniques in order from the highest level of arousal of situational interest were hands-on activities, science magic, demonstrations, anecdotes, use of toys, analogies, and fun facts. T-tests showed no significant differences in scores for the three highest scoring activities: hands-on, science magic, and demonstrations.

5.5 Correlations

In this section, the correlations between individual interest in science measured in Survey 2 (“Personal Interest in Science”) and personal science teaching efficacy (PSTE) measured in Survey 3 (Science Teaching Efficacy Belief Instrument-STEBI-B) at the three time points are analysed. In addition, correlations between the three times of testing of individual interest and correlations between the three times of testing of self-efficacy are analysed.

Interest in Science Topics (List A) and Interest in Science Topics (List B) of
Survey 1 were not included in the correlational analyses because they are lists of science topics taught or not taught by the researcher, not scales measuring an underlying construct. Also, correlations involving the science teaching outcome expectancy measure (STOE) from Survey 3 were not included in the correlation matrix produced in Table 24 because it was not a particularly robust measure. The Cronbach alpha was just above .70 on the three occasions it was administered. In addition, the correlations with individual interest and STOE were not strong. The STOE items in Survey 3 refer to teachers in general rather than to the particular teacher completing the survey (the word “I” is used in the personal science teaching efficacy, or PSTE items, but it is not used in the STOE). This lack of direct personal input in the items may help to explain why the STOE scale was less robust than the PSTE scale.

Table 24

Correlations between Individual Interest in Science (PI) and Personal Science Teaching Efficacy (PSTE) at Times 1, 2, and 3

<table>
<thead>
<tr>
<th></th>
<th>PI Time 1</th>
<th>PI Time 2</th>
<th>PI Time 3</th>
<th>PSTE Time 1</th>
<th>PSTE Time 2</th>
<th>PSTE Time 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>PI</td>
<td>1.0</td>
<td>.36**</td>
<td>.24**</td>
<td>.37**</td>
<td>.11</td>
<td>.11</td>
</tr>
<tr>
<td></td>
<td>(n = 199)</td>
<td>(n = 136)</td>
<td>(n = 313)</td>
<td>(n = 199)</td>
<td>(n = 199)</td>
<td>(n = 136)</td>
</tr>
<tr>
<td>PI</td>
<td>1.0</td>
<td>.61**</td>
<td>.07</td>
<td>.39**</td>
<td>.23**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(n = 105)</td>
<td>(n = 199)</td>
<td>(n = 199)</td>
<td>(n = 105)</td>
<td>(n = 105)</td>
<td></td>
</tr>
<tr>
<td>PI</td>
<td>1.0</td>
<td>.12</td>
<td>.28**</td>
<td>.35**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(n = 136)</td>
<td>(n = 104)</td>
<td>(n = 136)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSTE</td>
<td>1.0</td>
<td></td>
<td></td>
<td>.28**</td>
<td>.32**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(n = 199)</td>
<td></td>
<td></td>
<td>(n = 136)</td>
<td>(n = 136)</td>
<td></td>
</tr>
<tr>
<td>PSTE</td>
<td>1.0</td>
<td></td>
<td></td>
<td>.46**</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>(n = 104)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PSTE</td>
<td>1.0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

** p < .01; Time 1 = Pretest, Time 2 = Immediate posttest, Time 3 = Delayed posttest
5.5.1 Links between reported individual interest in science and personal science teaching efficacy at the three time points

It was notable that there was a relatively strong and consistent correlation between reports of individual interest in science measured in Survey 2 and personal science teaching efficacy measured in Survey 3 at the three times in which these constructs were measured: Pretest (Time 1), $r = .37^{**}$; Immediate posttest (Time 2), $r = .39^{**}$; Delayed posttest (Time 3), $r = .35^{**}$.

It was anticipated that the teaching activities presented by the researcher during the science unit would have three consequences. First, there would be an increase in students’ situational interest in science. Second, as a result of exposure to multiple activities that aroused situational interest in science, students’ personal interest in science would increase. Third, there would be an increase in students’ self-efficacy to teach science. Self-efficacy was expected to rise because the researcher explained science concepts clearly and almost all of the activities she provided could be used by the student teachers themselves when they were teaching science in primary classrooms. Preservice primary teachers who were nervous about teaching science because they lacked a strong background in it (and many would fit this category) would feel more confident as a result of the science unit and the activities that occurred during the semester.

The repeated measures analyses reported earlier in this chapter do show significant rises in individual interest in science and self-efficacy to teach science from Time 1 (pretest) to Time 2 (immediate posttest). From Time 2 to Time 3 (delayed posttest) there is drop in individual interest (but it remains significantly higher than at Time 1). Self-efficacy does not drop from Time 2 to Time 3.
Even though scores for reported individual interest in science and self-efficacy to teach science increased for most preservice primary teachers from Time 1 to Time 2, the correlations between the two constructs remained very similar. The relationship also remained when at Time 3 scores dropped somewhat for individual interest but remained constant for self-efficacy. Students who find science interesting are more likely to feel confident about teaching science than students who do not find science interesting. The consistency and strength of the correlations between individual interest and self-efficacy provide a measure of validity for the new individual interest in science scale that was developed for the current study because one would expect these constructs to be related.

Correlations cannot establish causality but it is interesting to speculate on the relationship between these two constructs. Did the easy-to-use teaching techniques and clear explanations of science concepts reduce the anxiety of preservice primary teachers, raise their motivation because they experienced success in learning, and thereby enhance their self-efficacy to teach science? As a result of heightened self-efficacy perhaps students felt more positively towards science and this increased their reports of individual interest in science. Alternatively, the situational interest generated by teaching techniques and clear explanations of science concepts engendered an individual interest in science. The motivation that comes from feeling successful (now I understand science) and a growing individual interest in science may have increased students’ self-efficacy to teach science.

Given that the strength of the correlation between individual interest and personal science teaching efficacy remained relatively stable at all three time points,
even at Time 1 before the science unit began, one could mount the argument that the causal path is from individual interest in science to self-efficacy to teach science. If, as a primary teacher, I can understand science concepts and find them interesting and relevant to my future teaching career, then I would be motivated to pass on my understanding and interest to my students. I would expect that I would be able to teach science effectively because I understand it and I enjoy learning about it. However, the relationship between these two measures probably is bi-directional: interest in science enhances self-efficacy to teach science and self-efficacy to teach science enhances interest in science.

5.5.2 Links between individual interest in science at Times 1, 2, and 3

There were significant positive correlations between individual interest in science at the three times of testing: Time 1 and Time 2, \( r = .36** \); Time 1 and Time 3, \( r = .24** \); and Time 2 and Time 3, \( r = .61** \). The significant positive correlation for individual interest between Time 1 and Time 2 demonstrates that, even though individual scores for interest rose from Time 1 to Time 2, the students who scored towards the high end of the scale at Time 1 were the students who scored towards the high end of the scale at Time 2 (moving closer towards the high end of the scale), and conversely, the students who scored towards the low end of the scale at Time 1 were the students who scored towards the low end at Time 2 (but higher than they did at Time 1).

The very strong correlation between students’ individual interest scores at Time 2 and Time 3 is noteworthy \( (r = .61) \). There was a significant fall in individual interest from Time 2 to Time 3. Again, the relative position of the students appears to
be quite stable. That is, students scoring towards the high end of the scale at Time 2 also score towards the high end at Time 3 (but a little lower), and students who score towards the low end at Time 2 score towards the low end at Time 3 (but a little lower). Given that there was no additional science input between Times 2 and 3 perhaps students’ level of individual interest in science is stabilising, so that knowing students’ scores at Time 2 is a good predictor of their scores at Time 3. It is interesting to note that the standard deviation of individual scores around the mean for individual interest at Time 1 was greater than it was for individual interest at Time 2 or Time 3.

5.5.3 Links between personal science teaching efficacy at Times 1, 2, and 3

A similar pattern emerged for personal science teaching efficacy (PSTE). There were significant positive correlations between PSTE at the three times of testing: Time 1 and Time 2, $r = .28**$; Time 1 and Time 3, $r = .32**$; and Time 2 and Time 3, $r = .46**$. Students with high personal science teaching efficacy to teach science maintained a higher self-efficacy compared with students with a lower self-efficacy. Again, the strongest correlation emerged between Time 2 and Time 3 ($r = .46**$), though it was not as strong as the correlation between individual interest at Times 2 and 3. Perhaps this also was a sign that students’ self-efficacy to teach science was becoming more stable.
5.6 Summary of Chapter 5

This study was designed to answer the following main question: does repeated exposure to activities designed to enhance preservice primary teachers’ situational interest in science enhance their longer term individual interest in science? In addition, a second question was posed: does repeated exposure to activities designed to enhance preservice primary teachers’ situational interest in science also enhance their self-efficacy to teach science? A longitudinal research design was adopted to look for evidence of sustained individual interest in science and sustained self-efficacy to teach science. Data were gathered at three points in time: at the beginning of the science unit; at the end of the science unit; and ten months after the science unit was completed.

A new scale was devised to measure individual interest in science. It demonstrated strong internal consistency across the three times of measurement. Self-efficacy to teach science was measured by an existing scale, Science Teaching Efficacy Belief Instrument (STEBI-B). This scale contained two sub-scales: the Personal Science Teaching Efficacy scale (PSTE) and the Science Teaching Outcome Expectancy scale (STOE). A second measure of students’ individual interest in science was Interest in Science Topics. Students were asked to indicate their interest in 20 science topics at the three time points. Ten of the 20 topics were taught during the semester. A range of activities designed to generate situational interest in science was devised and presented to students during the semester long science unit.

At the end of the unit, students were asked to indicate the level of situational
interest they experienced with different types of activities (for example, hands-on activities, science magic and fun facts about science). Participants reported that almost all the activities introduced during the science unit aroused their interest. Three types of activity rated particularly high: hand-on activities, science magic, and demonstrations. Only fun facts rated below 4 on a five point scale.

Results showed that students’ reported individual interest in science rose significantly from the pretest (Time 1) to the immediate posttest (Time 2). There was a significant decrease in reported individual interest in science from the immediate posttest (Time 2) to the delayed posttest (Time 3), though interest remained significantly higher than it was at the pretest. A similar pattern emerged for Interest in Science Topics both for List A (topics taught be the researcher) and List B (topics not taught be the researcher). It was interesting to note that Interest in Science Topics not taught by the researcher (List B) also rose, though not as significantly as List A.

Results showed that students’ Personal Science Teaching Efficacy (PSTE) also rose significantly from the pretest (Time 1) to the immediate posttest (Time 2). Unlike individual interest in science there was no decrease in PSTE from the immediate posttest (Time 2) to the delayed posttest (Time 3). A similar pattern emerged for the Science Teaching Outcome Expectancy scale (STOE), though the increase in scores was not as pronounced as it was for the PSTE scale. It is notable that PSTE to teach science did not diminish from Time 2 to Time 3 (though there was a downward trend in scores while reported individual interest in science did diminish). One might expect that confidence to teach science would remain more stable over time than interest in science itself. The relationship between individual
interest in science and self-efficacy to teach science is discussed further in a following paragraph.

Correlations between individual interest in science and self-efficacy to teach science were examined at the three times of measurement. A strong positive correlation emerged at each time point. It was not possible to establish causality, but an argument can be mounted that interest in science enhances one’s confidence to teach science. It is likely, however, that there is a two-way relationship between these two constructs: interest in science enhances self-efficacy to teach science and heightened self-efficacy to teach science enhances interest in science. The activities provided during the science unit were appealing for preservice primary teachers because they were activities that they themselves could use when they were teaching in primary classrooms. Relevance for future teaching careers of the activities was high. It appears that the activities provided during the science unit had two consequences: they enhanced participants’ interest in science and they enhanced participants’ self-efficacy to teach science.

There were other notable correlations. The correlation between participants’ individual interest in science at Time 2 (immediate posttest) and Time 3 (delayed posttest) was very strong, considerably stronger than the correlation at Time 1 and Time 2. Even though there was a significant decrease in individual interest in science from Time 2 to Time 3, the relative position of participants remained quite stable. Similarly, the correlation for self-efficacy to teach science was strongest at Time 2 and Time 3, though not as pronounced as it was for individual interest in science.
6.1 Introduction

This chapter presents the results of analyses of the qualitative data used to determine if there was evidence that preservice primary teachers experienced the following:

1. situational interest from the teaching techniques used during the science content unit;
2. an increase in individual interest for science as a result of regular arousal of situational interest;
3. an increase in self-efficacy to teach science as a result of regular use of teaching techniques to arouse situational interest.

The chapter is organised in the following way. Section 6.2 presents the results of coding of the three sets of responses to Questionnaire 1 to investigate whether situational interest was aroused during the science tutorials of weeks four, seven, and nine. Section 6.3 provides the results of Questionnaire 2, to look for evidence to explain any change in individual interest in science. Section 6.3 presents the results from individual interviews which were used to provide further evidence of situational interest and its possible relationship to individual interest and self-efficacy. The chapter summary is presented in Section 6.4.
6.2 Coding of Questionnaire 1: Evidence of Situational Interest

The purpose of this questionnaire was to establish whether or not situational interest occurred in the science unit, and to identify its possible sources. The participants were asked to write a short response to the request to “Write down anything that interested you during the tutorial. Please explain as fully as you can” (Appendix F).

Questionnaire 1 was administered in the tutorials of weeks four, seven, and nine. In total, the participants contributed 565 completed questionnaires. From Week Four, 229 questionnaires (labelled Week 4 for coding) were received; in Week Seven, 184 completed questionnaires were received (labelled Week 7 for coding); and in Week Nine, 156 questionnaires were received (labelled Week 9 for coding). Thirty randomly selected data samples from each of the three administrations were independently coded by two different people, the researcher and a colleague, to establish reliability of the coding. The results were 85%, 87%, and 91% agreement respectively for coded categories in each of the three administrations of Questionnaire 1.

6.2.1 Coding of Week 4 responses

1. Did situational interest occur?

All responses were carefully read. Due to the wording of the item, “Write down anything that interested you during the tutorial” any response that described anything from the tutorial was coded as a positive response. In other words, situational interest was coded as present if the student referred to something from the tutorial. Situational interest was coded as not present if the student stated clearly that
nothing had interested him or her during the tutorial. Other types of responses and blank responses were coded as Not Clear. All of the 229 completed questionnaires were coded as positive for situational interest occurring during the tutorial. No response had stated that nothing in the tutorial had interested the student. No blank responses were submitted. This indicated that 100% of the participants who attended the tutorial and who completed the questionnaire were categorised as having experienced situational interest.

2. Sources of situational interest

Verbatim descriptions were used initially to code the sources of situational interest, and then these were combined into broad categories. The broad categories created were the following: specific teaching techniques, relevance to teaching primary science, learning, novelty, teacher qualities, social interaction, and physical activity.

a) Specific teaching techniques

Responses were placed in this category if they made any mention of teaching techniques such as hands-on activities, anecdotes, demonstrations, analogies, fun facts, science magic, or toys that had taken place or used in the tutorial. It must be noted that the use of science magic and toys had not previously been reported in the literature as generating situational interest in science. Both were clearly described in responses as arousing interest.

The following are some examples of participant responses:

- “I found it very interesting that J outlined many principles of science using a
range of basic toys that can be taken for granted.”

- “I found all the practical activities very interesting.”
- “The demonstrations were easy, simple and demonstrated a wide variety of scientific principles. They aroused my interest.”
- “The stories, anecdotes, and facts told by the tutor were very interesting and motivating.”
- “The magic was interesting, engaging and entertaining but very useful and informative. The same for the toys and demonstrations.”
- “The magic wand was the most interesting thing today. Watching the metal foil float in mid-air and stick up on the roof was pretty cool to watch.”
- “Love hearing real life stories that promote interest for me.”
- “The experiments were all very interesting and fun, particularly finding out how the ‘fun fly stick’ toy created repulsion.”

b) Relevance to teaching primary science

Responses were assigned to this category if they made reference to future teaching careers or classroom applications. The following are some examples of student responses:

- “Learning interesting teaching techniques that will get the primary school students interested in science and get their minds active.”
- “Learning how to do inexpensive activities that will teach children about science.”
- “Strategies we can use when we become a teacher.”
- “The potential classroom applications for these demonstrations. All of the
demonstrations are easy, relevant, and something the students will enjoy. These simple demonstrations aroused my interest.”

- “The use of everyday objects to demonstrate science sparked an interest as it is easier to incorporate them into the classroom.”

**c) Learning**

Responses were placed in this category if they indicated that the student had learnt something or understood something. The following are some examples:

- “Personally, I think that using toys such as the ones today increased my interest and allows me to learn more effectively.”
- “Learning interesting teaching techniques that will get the primary school students involved in science” (obviously some overlap with relevance to teaching primary science)
- “I learned how we can demonstrate science to our own students in a fun and interesting way” (obviously some overlap with relevance to teaching primary science)

**d) Novelty**

Responses were placed in this category if they implied that things were new, unusual, or surprising. Responses were also placed in this category if they mentioned variety, as variety suggests newness. The following are some representative examples:

- “I learnt something new with the magic milk experiment.”
- “Using toys that I had not seen before I found really interesting.”
“I was interested the most by the magic wand toy as I found it surprising that electricity could cause an object to levitate.”

e) Teacher qualities

Responses were placed in this category if they implied that qualities of the teacher, such as enthusiasm and passion, had generated interest. The following are some examples:

- “J was very passionate about the topic, helped to keep us engaged in class.”
- “It’s all equally interesting because I feed off the energy that the teacher puts into it.”
- “The teacher’s support/communication.”
- “A good teacher interacts with the students and keeps them involved and that’s exactly what you did.”
- “I am a lot more interested in science because of you.”

f) Social interaction

Responses were placed in this category if they implied that interaction with the tutor or with other students had generated interest. The following are some examples.

- “I love how interactive the tutorials are, very interesting and relevant.”
- “The level of interest in science was raised through the use of interactions.”
- “All experiments with toys are interactive and give us a basic understanding of science. Also good to interact with other students.”
- “The extensive use of hands-on materials and social interactions between students and the tutor.”
g) Physical activity

Responses were placed in this category if they implied that physically manipulating objects or actively moving around the classroom had generated interest. The following are some examples.

- “Doing things instead of just theory made me interested.”
- “How we actually got to do things.”

Not Categorised

Some of the responses were not able to be categorised, either because they referred to the participant’s interest during the tutorial (such as “science is fun”) or because they were unclear (such as “good for students”). Also, some participants included causes of interest from other tutorials which were irrelevant to the Week 4 questionnaire.

3. Summary of the coding of Questionnaire 1 in Week 4

Table 26 shows the number of participants who were allocated to each coded category for the Week 4 tutorial. Many participants wrote a number of responses that were placed in more than one category. Also, participants reported more than one teaching technique that had aroused their interest resulting in a large percentage of 156% from the 357 responses coded in the specific teaching techniques category. As a result the percentages in Table 26 do not add up to 100% due to 571 responses provided by 229 students. All percentages in Table 25 were expressed to the nearest whole number.
Table 25

*Sources of Situational Interest in Week 4*

<table>
<thead>
<tr>
<th>Categories of situational interest</th>
<th>Number of responses in category</th>
<th>Proportion of total participants ($n = 229$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific teaching techniques</td>
<td>357</td>
<td>156%</td>
</tr>
<tr>
<td>Relevance to teaching primary science</td>
<td>83</td>
<td>36%</td>
</tr>
<tr>
<td>Learning</td>
<td>46</td>
<td>20%</td>
</tr>
<tr>
<td>Teacher qualities</td>
<td>27</td>
<td>12%</td>
</tr>
<tr>
<td>Novelty</td>
<td>20</td>
<td>9%</td>
</tr>
<tr>
<td>Social interaction</td>
<td>13</td>
<td>6%</td>
</tr>
<tr>
<td>Physical activity</td>
<td>9</td>
<td>4%</td>
</tr>
<tr>
<td>Not categorised</td>
<td>16</td>
<td>7%</td>
</tr>
</tbody>
</table>

Table 25 shows that the two major sources of situational interest were specific teaching techniques and relevance to primary teaching. Learning about science, teacher qualities and novelty were also important sources. Social interaction and physical activity were mentioned by relatively few students.

Since the participants indicated that a large range of teaching techniques had aroused their interest, then Figure 2 compares the frequencies of participants’ responses for each coded teaching technique. The teaching techniques were toy use, hands-on activities, demonstrations, stories and anecdotes, science magic, fun facts, and analogies. The use of science magic and toys had not previously been reported in literature as generating situational interest in science. Nonetheless, both toys and science magic had aroused situational interest in many participants according to their written responses, even with limited use of science magic in the tutorial.
6.2.2 Coding of Week 7 responses

1. Did situational interest occur?

The responses from the second administration of Questionnaire 1 were coded in the same way as the first administration. Of the 184 completed responses, 183 were coded positive for situational interest. One response was not clear because it only described interest aroused in the previous tutorial.

2. Sources of situational interest

To identify the sources of situational interest reported by the participants, further coding of the responses was undertaken. Because the same themes were discernible in Week 7 as in Week 4, the same broad categories were used. These categories showed that participants attributed their situational interest to the following activities: specific teaching techniques, relevance to teaching primary
science, learning, novelty, teacher qualities, social interaction, and physical activity.

a) Specific teaching techniques

Responses were placed in this category if they made mention of teaching techniques such as toys, hands-on activities, analogies, anecdotes, fun facts, or demonstrations that had taken place in the tutorial. The following are some examples of student responses:

- “Lots of very hands-on activities. These were engaging and interesting for me.”
- “Loved the optical illusion activities, they were very interesting! The appearance of objects moving when they are not.”
- “The straw and Blu-Tack pulse monitor practical really interested me. The faster the straw movement, the faster your heart is beating.”
- “Simple anatomy demonstrations were interesting.”
- “The squishy eye analogy. Felt like our eye feels when touched.”
- “All the magic eye activities and all the hands-on toys make learning about the body more interesting.”
- “The facts and the stories peaked my interest.”

b) Relevance to teaching primary science

Responses were assigned to this category if they made reference to future teaching careers or classroom applications. The following are some examples of student responses:

- “The class is great fun and practical and gives us ideas on different ways to engage students in science in our future careers.”
“Lots of hands-on activities to use in the classroom. Great ways to engage my students and get them interested in science.”

“I liked the human body tutorial, the cheap and easy ways to demonstrate to children where their organs are.”

“The way that illusions were explained in terms of a primary school setting.”

“Children would love the group activities.”

“Knowing that resources for my classroom do not have to cost a lot and the children will be able to gain a lot of meaning.”

c) Learning

Responses were placed in this category if they indicated that the student had learnt something or understood something. The following are some examples of participant responses:

“Learning about different parts of the body through demonstrations.”

“I loved the torso of the human body. So much easier to learn things with an interactive hands-on model.”

“Learning cheap, easy, fun ways to teach students about parts of the body.” (obviously an overlap with relevance to teaching)

“Learning information that is practical for real life teaching.” (obvious overlap with relevance to teaching)

d) Novelty

Responses were placed in this category if they implied that things were new, unusual, or surprising. Responses were also placed in this category if they mentioned
variety, as variety suggests newness. The following are some verbatim quotes:

- “The optical illusions were interesting but strange.”
- “The optical illusions were interesting because they were something I’ve never seen before.”
- “The growing bunny was unusual. Just watching it get bigger and smaller.”
- “The variety of activities really interested me.”

e) Teacher qualities

Responses were placed in this category if they implied that qualities of the teacher, such as enthusiasm, had generated interest. The following are some examples:

- “J’s funny, enjoyable class.”
- “Of course, the teacher’s youthful enthusiasm.”
- “J’s sense of humour as always.”

f) Social interaction

Responses were placed in this category if they implied that interaction with the tutor or with other students had generated interest. The following are some examples.

- “The use of class discussions I found interesting as many of the class got involved. It was a valuable lesson.”
- “Playing games and with toys, all interactive activities.”
- “The social interaction of playing games together was fun and interesting.”
- “Participating in the group activities.”


g) Physical activity

Responses were placed in this category if they implied that physical manipulation of objects or moving around the classroom had generated interest. The following are some examples.

- “I was interested in physically putting body parts together.”
- “The apron of the human body organs and actually being able to physically Velcro the organs on.”
- “I liked touching and playing with all the materials.”
- “Building and playing with the body models.”

Not categorised

A small number of responses were not able to be categorised because there was no indication of a specific activity. For example, participants wrote “entertaining” or “helpful.” Also, some participants included causes of interest from other tutorials which were irrelevant to the Week 7 questionnaire.

Summary of the coding of Questionnaire 1 in Week 7

Table 26 shows the number of responses allocated to each category for the Week 7 tutorials. Note that many participants wrote a number of responses that were placed in more than one category. Similar to Week 4 results, this was especially the case with the large percentage of specific teaching techniques due to more than one technique being identified by participants as stimulating their interest during the tutorial. As a result, the total of all category percentages in Table 26 do not add up to 100% from 663 responses being provided by 184 study participants. All percentages
in Table 26 were expressed to the nearest whole number.

Table 26

Sources of Situational Interest in Week 7

<table>
<thead>
<tr>
<th>Categories of situational interest</th>
<th>Number of responses in category</th>
<th>Percentage of total participants (n = 184)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific teaching techniques</td>
<td>386</td>
<td>210%</td>
</tr>
<tr>
<td>Relevance to teaching primary science</td>
<td>97</td>
<td>53%</td>
</tr>
<tr>
<td>Learning</td>
<td>69</td>
<td>38%</td>
</tr>
<tr>
<td>Novelty</td>
<td>35</td>
<td>19%</td>
</tr>
<tr>
<td>Physical activity</td>
<td>32</td>
<td>17%</td>
</tr>
<tr>
<td>Teacher qualities</td>
<td>22</td>
<td>12%</td>
</tr>
<tr>
<td>Social interaction</td>
<td>14</td>
<td>8%</td>
</tr>
<tr>
<td>Not categorised</td>
<td>8</td>
<td>4%</td>
</tr>
</tbody>
</table>

Similar to the responses in Week 4, this table shows that the two major sources of situational interest were specific teaching techniques and relevance to primary teaching. Learning, novelty and physical activity were also important sources, but teacher qualities and social interaction were mentioned by relatively few students.

The numbers of participants who cited a specific teaching technique are shown in Figure 3 below. There were 386 responses for specific teaching techniques of toy use, hands-on activities, demonstrations, stories and anecdotes, fun facts, and analogies. Science magic was not used in this tutorial. There were many comments about toys arousing interest.
Figure 3. Frequencies of responses for the teaching techniques: toy use (1), hands-on activities (2), demonstrations (3), stories and anecdotes (4), science magic (5, not used in this tutorial), fun facts (6), and analogies (7) in the Week 7 tutorial.

6.2.3 Coding of Week 9 responses

1. Did situational interest occur?

The responses from this third administration of Questionnaire 1 were coded in the same way as the two previous administrations. Of the 156 completed responses, 153 were coded positive for situational interest. One participant had reported not finding anything interesting in the tutorial. One response was not clear because it only described interest aroused in the previous tutorial. There was one blank response.

2. Sources of situational interest

Further coding of the responses was undertaken to identify the sources of situational interest reported by the participants. Because the same themes were discerned in Week 9 as in Weeks 4 and 7, the same broad categories were used:
specific teaching techniques, relevance to teaching primary science, learning, novelty, teacher qualities, social interaction, and physical activity.

a) Specific teaching techniques

Responses were placed in this category if they made any mention of teaching techniques such as toys, hands-on activities, analogies, anecdotes, fun facts, or demonstrations. The following are some examples of responses:

- “The examples of fossils used were a very useful source in gaining my attention.”
- “Seeing and holding actual samples of prehistoric life was definitely interesting!”
- “The story about the saint who had turned the snakes into fossils. It was interesting to hear views by people in the past and be able to look back now and see what really happened.”
- “Playing with the dinosaur toys.”
- “It was really interesting to see amber with an insect in it.”
- “The practical demonstration of natural selection as it allowed a better understanding of how adaptations can help certain animals.”

b) Relevance to teaching primary science

Responses were assigned to this category if they made reference to future teaching careers or classroom applications. The following are some examples of responses:

- “Demonstration of how we can utilise props like puppets and toys to interest
our students.”

- “Easy to do activities appropriate for K-6 students.”
- “It was a good technique to use the beans and pegs, spoons, forks and chopsticks as bird beaks to show children how natural selection occurs.”
- “All the ideas on how to use the activities within the classroom.”
- “The dinosaur toys and puppets were great ideas for the classroom.”
- “I was interested in the demonstration to explain natural selection to primary school kids. I like how something simple can explain something scientific.”

c) Learning

Responses were placed in this category if they indicated that the student had learnt something or understood something. Here are some responses:

- “Playing the natural selection game because it was an interesting and fun way to learn about the concept of evolution.”
- “The exercise of demonstrating how natural selection occurs using coloured beads in the grass helped me to better understand.”
- “Learning about the evolution of life. It was great to be able to see life in its earliest forms.”
- “Learning about dinosaurs that kids will be interested in as well.” (overlap with relevance to teaching)

d) Novelty

Responses were placed in this category if they implied that things were new, unusual, or surprising. Responses were also placed in this category if they mentioned
variety because variety suggests newness. The following are some examples:

- “I found all the fossils quite interesting as they are something that I have not seen before. The fossil display was great!”
- “Being able to see things I’ve never seen before was an interesting experience.”
- “Learned something new.”

e) Teacher qualities

Responses were placed in this category if they implied that qualities of the teacher, such as enthusiasm, had generated interest. The following are some examples of responses:

- “J’s engaging delivery when talking about the fossils.”
- “So much knowledge evident in the way J explains everything well, and how passionate she is.”
- “J’s overall enthusiasm to the topic was awesome and made the tutorial a lot more interesting.”
- “J’s explanations of the fossils and enthusiasm make the tutorial exciting.”

f) Social interaction

Responses were placed in this category if they implied that interaction with the tutor or with other students had generated interest. The following are some examples.

- “The in-depth discussions we had in the tutorial.”
- “The discussions involving the class talking about ancient man were very interesting.”
▪ “The class asking questions about the fossils and J giving the answers."

**g) Physical activity**

Responses were placed in this category if they implied that physical manipulation of objects or moving around the classroom had generated interest. The following are some examples:

▪ “Being able to physically manipulate fossils made learning about evolution more realistic and concrete.”

▪ “Looking at and touching all the fossils.”

**Not categorised**

A small number of codes were not able to be categorised because no activity was mentioned, for example, “entertaining materials” or “really fascinating.” Some participants included causes of interest from other tutorials which were irrelevant to the week 9 class.

**3. Summary of the coding of Questionnaire 1 in Week 9**

Table 27 shows the number of responses that were allocated to each category for the Week 9 tutorials. Similar to Week 4 and Week 7, many participants wrote responses that were placed in more than one category. As well, this was particularly evident for the specific teaching techniques with 282 responses because more than one technique was often described by participants as arousing their interest. Hence, there were 440 responses in total provided by 156 study participants resulting in the total percentages for the categories in Table 27 not adding up to 100%. The teaching techniques were toy use, hands-on activities, demonstrations, stories and anecdotes,
fun facts, and analogies. Science magic was not used in this tutorial. The numbers of responses for each teaching technique are provided in Figure 4.

Table 27

Sources of Situational Interest in Week 9

<table>
<thead>
<tr>
<th>Categories of situational interest</th>
<th>Number of responses in category</th>
<th>Proportion of total participants (n = 156)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific teaching techniques</td>
<td>282</td>
<td>181%</td>
</tr>
<tr>
<td>Learning</td>
<td>65</td>
<td>42%</td>
</tr>
<tr>
<td>Teacher qualities</td>
<td>32</td>
<td>21%</td>
</tr>
<tr>
<td>Relevance to teaching primary science</td>
<td>18</td>
<td>12%</td>
</tr>
<tr>
<td>Novelty</td>
<td>15</td>
<td>10%</td>
</tr>
<tr>
<td>Physical activity</td>
<td>14</td>
<td>9%</td>
</tr>
<tr>
<td>Social interaction</td>
<td>8</td>
<td>5%</td>
</tr>
<tr>
<td>Not categorised</td>
<td>6</td>
<td>4%</td>
</tr>
</tbody>
</table>

This table shows that specific teaching techniques and learning were the two major sources of situational interest. Relevance to teaching primary science, novelty, and physical activity were also important sources. Social interaction was mentioned in relatively few responses. All percentages in Table 27 were expressed to the nearest whole number.
6.2.4 Comparison of sources of situational interest

Of the 569 questionnaires completed by participants during Week 4, Week 7, and Week 9 tutorials, 99.2% reported situational interest. Coding of the three administrations of the same open-ended questionnaire resulted in participants’ nominating the same sources of situational interest, even though the science topic was different (Week 4, Energy; Week 7, The Human Body; Week 9 Natural selection). The reliability of the coding of each time Questionnaire 1 was administered was demonstrated by two different people, the researcher and a colleague, who independently coded thirty of the same questionnaires. The level of agreement of the independent coding of Questionnaire 1 for Week 4, Week 7, and Week 9 were 85%, 87%, and 91% respectively.

The main sources of situational interest were specific teaching techniques, relevance to teaching primary science, learning, teacher qualities, novelty, physical activity, and social interaction. Table 28 shows that the relative proportions of each
of these did vary from week to week. This may have been because different topics or activities were offered each week. However, the overall pattern was that specific teaching techniques, relevance to teaching primary science, and learning were the three most commonly mentioned sources of interest, although there were significant proportions of other sources as well. As noted earlier, the categories were not independent of each other. For example, in a number of quotes, participants indicated that an activity stimulated interest in two ways: the sense of success they felt when they understood something for the first time, and the sense of relevance that they will be able to teach this to children at a later date. Watching and understanding a science demonstration that could be used in a primary classroom could have the same dual effect: a sense of success in learning and a sense of relevance for teaching.

Table 28

Percentages of Responses for Different Sources of Situational Interest

<table>
<thead>
<tr>
<th>Categories</th>
<th>Proportion of students (n = 229) in Week 4</th>
<th>Proportion of students (n = 184) in Week 7</th>
<th>Proportion of students (n = 156) in Week 9</th>
<th>Proportion of students (n = 569) in Weeks 7, 8, 9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teaching techniques</td>
<td>156%*</td>
<td>210%*</td>
<td>181%*</td>
<td>182%*</td>
</tr>
<tr>
<td>Relevance to teaching primary science</td>
<td>36%</td>
<td>53%</td>
<td>12%</td>
<td>34%</td>
</tr>
<tr>
<td>Learning</td>
<td>20%</td>
<td>38%</td>
<td>42%</td>
<td>33%</td>
</tr>
<tr>
<td>Teacher qualities</td>
<td>12%</td>
<td>12%</td>
<td>21%</td>
<td>15%</td>
</tr>
<tr>
<td>Novelty</td>
<td>9%</td>
<td>19%</td>
<td>10%</td>
<td>13%</td>
</tr>
<tr>
<td>Physical activity</td>
<td>6%</td>
<td>17%</td>
<td>9%</td>
<td>11%</td>
</tr>
<tr>
<td>Social interaction</td>
<td>4%</td>
<td>8%</td>
<td>5%</td>
<td>6%</td>
</tr>
<tr>
<td>Not coded</td>
<td>7%</td>
<td>4%</td>
<td>4%</td>
<td>5%</td>
</tr>
</tbody>
</table>
As can be seen in Table 28, the percentages total more than 100%. This was partly due to more than one kind of teaching technique being used during tutorials allowing participants to provide responses to more than one technique if the technique aroused their interest. Also, many participants wrote responses that were placed in more than one category.

6.3 Questionnaire 2: Reasons for Change in Individual Interest in Science

The purpose of this questionnaire was to examine causality in any change in reported individual interest in science (Appendix G). This questionnaire had two questions: *Has your interest in science changed while doing this science unit?*, and *What caused a change, or not, in your interest in science? Please explain as fully as possible.* This questionnaire was handed to students by a person not associated with the science unit. This occurred on one occasion at the end of the final tutorial of the science unit. From the ten tutorial groups, there were 205 completed questionnaires. All questionnaires (66% response rate) were completed for item one but eight of the questionnaires were blank for item two.

1. Coding process for Item 1: Was there any change in individual interest in science?

Participants were asked to indicate if they had experienced an increase in interest in science, no change in interest in science, or a decrease in interest in science.

A. Increase in interest in science

Of the 205 participants, 186 (90.7%) indicated an increase in interest in
B. No change in their interest in science

Of the 205 participants, there were 19 (9.3%) participants who indicated no change in an interest for science, but 11 of these participants explained that they already had an interest for science.

C. Decrease in interest for science

This choice for reporting a decrease in interest for science received zero responses.

The summary of the item one responses is presented in Table 29 which show that approximately 91% of the participants had increased their interest in science.

Table 29

Results for Item 1 of Questionnaire 2

<table>
<thead>
<tr>
<th>Item 1 choices</th>
<th>Number of participants (n = 205)</th>
<th>Percentage of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>A – Increase in interest</td>
<td>186</td>
<td>90.7</td>
</tr>
<tr>
<td>B – No change in interest</td>
<td>19</td>
<td>9.3</td>
</tr>
<tr>
<td>C – Decrease in interest</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

2. Coding process for Item 2: What were the reasons for change in individual interest?

Coding for choice “A” for an increase in interest responses

Item two asked the participants to provide a written response to explain what caused any change in their interest in science. After reading the responses, word labels representing literal descriptors were used to code the text segments for reasons
for change in individual interest. The reliability of the coding was checked having by two people, the researcher and a colleague, independently coding the same thirty data transcripts. There was 93% agreement. Initial codes that appeared to overlap in meaning were combined into broader categories. The broad categories created were the following: *specific teaching techniques, relevance to teaching primary science, teacher qualities, learning, and novelty*. The categories of *social interaction* and *physical activity* that emerged in the analysis of Questionnaire 1 were not identified in these responses.

a) *Specific teaching techniques*

Responses were placed in this broad category if they made any mention of teaching techniques such as toys, hands-on activities, science magic, analogies, anecdotes, fun facts, or demonstrations that had taken place in the tutorial.

The following are some examples of responses:

- “The hands-on simplistic approach to learning and the enthusiastic, passionate way it was conveyed made it more enjoyable and increased my interest.”
- “The teaching techniques have improved my interest in science.”
- “Fun activities, easy explanation of facts, plenty of hands-on activities increased my interest.”
- “Teaching of science with simple experiments, toys, demonstrations, and magic with explanations that were not complex changed my interest in science.”
- “The practical activities, demonstrations, the interesting facts, and stories taught to me increased my interest in science.
b) Learning

Responses were placed in this category if they indicated that the student had learnt something or understood something. Here are some examples of responses:

- “I have gained an increased understanding of science which has led to an increase in my interest.”
- “I increased my interest because of the way the science was presented allowing me to learn in a non-complex or non-overwhelming way.”
- “This subject extended my knowledge and made me realise that I now find it very interesting.”

c) Relevance to teaching primary science

Responses were assigned to this category if they made reference to future teaching careers or classroom applications. The following are some samples of responses:

- “Learning more about the concepts and ways to teach these to primary students. This makes me confident, therefore giving me greater interest in science and teaching to my students.”
- “My interest has increased because I now feel more confident and equipped to teach it in my classroom.
- “My interest in science has changed due to the activities given on how to make science more engaging and fun in the classroom.”

d) Teacher qualities

Responses were placed in this category if they implied that qualities of the
teacher, such as enthusiasm, had generated interest. The following are some samples of responses:

- “The enthusiasm shown by J... for science was catching and made me more interested in science.”
- “The teacher’s enthusiasm in teaching science has increased my interest.”
- “J’s enthusiasm in science got me keen to learn and explore the science concepts.”

e) Novelty

Responses were placed in this category if they implied that things were new, unusual, or surprising. Responses were also placed in this category if they mentioned variety, as variety suggests newness. The following are some examples:

- “I learned things that were new and unfamiliar.”
- “Seeing so many new things!”
- “The surprising facts and stories were fascinating.”
- “So many different activities and resources I have never seen before!”

Not categorised

Three codes were not included for the broad categories because the responses did not mention actual activities. Instead, the responses had the words “useful”, “exciting”, and “science more accessible”.

Summary of coded responses related to choice “A” in Questionnaire 2

Table 30 shows the number of responses allocated to each broad category. Some participants wrote responses that were placed in more than one category
resulting in percentages in Table 30 totalling more than 100%. This table shows that the main reasons for a change in individual interest in science were the following: *specific teaching techniques, learning, relevance to teaching primary science, teacher qualities,* and *novelty.* However, novelty was mentioned by relatively few students.

Table 30

*Causes of Increase in Individual Interest*

<table>
<thead>
<tr>
<th>Categories</th>
<th>Number of responses</th>
<th>Proportion of total participants ($n = 205$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specific teaching techniques</td>
<td>91</td>
<td>44%</td>
</tr>
<tr>
<td>Learning</td>
<td>70</td>
<td>34%</td>
</tr>
<tr>
<td>Relevance to teaching primary science</td>
<td>69</td>
<td>34%</td>
</tr>
<tr>
<td>Teacher qualities</td>
<td>60</td>
<td>29%</td>
</tr>
<tr>
<td>Novelty</td>
<td>13</td>
<td>6%</td>
</tr>
<tr>
<td>Not categorised</td>
<td>3</td>
<td>1%</td>
</tr>
</tbody>
</table>

*Analysing Item 2 responses of participants who indicated no change in level of interest in science*

Of the 19 participants who indicated no change in interest in science, eight participants did not provide a written response to Item 2. The other 11 participants indicated that they were already interested in science before undertaking the science unit. Nonetheless, according to their written comments, the science unit had continued their interest, increased their learning, and improved their preparation for future teaching. The written responses from these participants included:

- interesting tutorial activities (nine responses)
- learning of science (nine responses)
- relevance to future teaching (eight responses)
- appreciation of the teacher (four responses)

Examples of quotes for participants who indicated that their level of interest in science had not changed:

- “The activities were interesting and fun with many useful ideas for the classroom which made me more confident in my ability to teach science.”
- “I was always interested in science and this course has helped me feel comfortable in preparing to teach it”.
- “Learning and teaching science with the use of games, stories, hands-on, facts, and demonstrations was interesting and fun.”
- “I was already extremely interested. J’s teaching style and suggestions for enhancing the teaching of science in the classroom further encouraged my learning.”

In summary, Questionnaire 2 provided evidence that approximately 91% of the participants (n = 205) indicated that their interest in science had increased during the science content unit. No participants indicated that their interest in science had decreased. From the participants’ responses, the reasons for a positive change in individual interest in science were attributed to specific teaching techniques, learning science, relevance to teaching primary science, and teacher qualities.
6.4 Individual Interviews

The main purpose of the interviews was to look for evidence of an increase in individual interest in science. Could this change be linked to situational interest generated during the science unit? Additionally, the interviews were intended to determine whether self-efficacy had changed and why this had occurred. The reliability of the coding of interview responses was checked by two different people, the researcher and a colleague, independently coding all 25 data transcripts resulting in 89% agreement. All interview questions were presented in Chapter 4.

Twenty-five students volunteered to be individually interviewed. Their gender and ages were broadly similar to those of the cohort as a whole (see Table 31). The interviews were conducted relatively soon after the science unit had finished. The interviews were audio-taped and then transcribed.

Table 31

**Details of Students Interviewed**

<table>
<thead>
<tr>
<th>Student information</th>
<th>Number of students/25</th>
<th>Percentage of total number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gender</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>5</td>
<td>20%</td>
</tr>
<tr>
<td>Female</td>
<td>20</td>
<td>80%</td>
</tr>
<tr>
<td>Age range of students</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18-22</td>
<td>11</td>
<td>44%</td>
</tr>
<tr>
<td>23-27</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>28+</td>
<td>12</td>
<td>48%</td>
</tr>
</tbody>
</table>

The following procedure was used in the analysis of their interview responses. As stated in Chapter 4, several questions were used to explore important aspects of the study. For example, Questions 1, 2, 3, 4, 5, and 6 were used to establish whether
there had been a change in individual interest. These questions are listed below.

1. Has the unit changed your interest in science?
2. Before the unit, what was your interest in science?
3. What is your interest in science after the unit?
4. On a scale of “negative, neutral, positive” what was your interest in science before the unit?
5. On a scale of “negative, neutral, positive” what is your interest in science after the unit?
6. Has there been any change in your behaviour with respect to science since you began the unit?

Questions 7, 8, and 9, as listed below, were used to establish whether any changes had been caused by situational interest.

7. Was there anything that happened in the unit that helped increase your interest in science?
8. Did that interest you at the time?
9. Why did that interest you at the time?

Questions 10, 11, 12, 13, and 14, as listed below, were used to establish if a change in self-efficacy to teach science had occurred.

10. Has the unit changed your confidence to teach science?
11. What was your confidence to teach science like before the unit?
12. What is your confidence to teach science like now after the unit?
13. On a scale of “positive, neutral and negative” before the unit what would your confidence to teach science have been?
14. On a scale of “positive, neutral and negative” after the unit, what would your confidence to teach science be now?

Questions 15 and 16 were used to identify reasons for a student’s change in self-efficacy to teach science:

15. What happened in the unit that helped to make you more confident to teach science?

16. Did that help to increase your confidence in science?

Thus, the same general question was asked in different ways. This strategy was used to enhance the validity and reliability of the interview data. Validity is enhanced when items that measure the same trait are correlated, and reliability is enhanced when two measures of the same trait are given at about the same time (McMillan & Schumacher, 2010). When multiple questions are used to obtain data, it is important to establish the extent to which the responses are congruent.

In each of the sections below, the procedures used to establish congruence are explained. The details of the coding for each of the interview questions are as follows.

6.4.1 Changes in individual interest in science (Questions 1-6)

The purpose of Questions 1-6 was to determine if change in individual interest had occurred during the science unit. A positive change in individual interest was coded when the responses to Questions 2 and 3 were coded as “positive change”, AND the responses to Questions 4 and 5 were coded as “positive change”, AND the responses to Questions 1 and 6 were both coded as “compatible with a positive change”. Any responses that did not have this degree of congruence were coded as
“not clear.” Conversely, a negative change in individual interest in science would have been coded when consistent negative responses would have been recorded for Questions 1-6. However, this did not occur.

**Question 1: Has the unit changed your interest in science?**

The responses to this question were coded as either “compatible with a positive change”, “compatible with no change”, “compatible with a negative change”, or “not clear”. The category “compatible with a positive change” was used when a response was compatible with either a stated positive change or an implied positive change even though the student may not have stated it explicitly. The category of “compatible with no change” was for use when a response, either implied or stated, could be interpreted as indicating no change. The category “compatible with a negative change” was for use when a response was either an implied or stated change indicating a decrease in interest as a result of the science unit. The category of “not clear” was for use when a response could not otherwise be categorised.

The result of the coding process for Question 1 was that all 25 interviewees were coded as “compatible with a positive change”. The following are examples of their responses to the question “Has the unit changed your interest in science?”

- “It did. Mainly through the experiments and the analogies that J used. A lot of the demonstrations she did made it a little bit exciting and as well using everyday objects made it more relatable. So that increased my interest.”
- “I did enjoy science a lot. I did enjoy space science. But knowing more about it has made me more interested.”
- “Most definitely. I definitely would be more ready to research things myself”
just for personal interest. Just from J speaking in lectures and stuff like that.”

- “Yes, it has probably broadened it. I was always really interested in the human anatomy side of things and biology. But the space stuff has really broadened my interest level.”

- “Definitely. Absolutely. I was never interested in science. I’d always found it rather boring and confusing at school. But I found that the lectures and the classroom activities really changed it. It was fantastic.”

- “Before the course I had no interest whatsoever. Then I couldn’t not go to the tutorials. I just loved them. I found them so interesting and so relevant to what I’m doing.”

- “It did change, yeah. I wasn’t interested at all before. …. And then starting this course I was like ‘Oh! Great science (not), but it was really interesting and I really enjoyed it’.

**Question 2: Before the unit, what was your interest in science?**

**Question 3: What is your interest in science after the unit?**

When coding the responses to Questions 2 and 3, a “positive change” was recorded if the response for question 2 indicated a lower interest in science than the response for Question 3. Either response could be explicitly stated or implied. A “negative change” could be coded if the response for Question 2 described a higher interest in science than the response for question 3. The coding of “no change” could be recorded if there was no difference in the interest described for both Questions 2 and 3. The category of “not clear” could result from responses that could not otherwise be categorised.
The comparison of coding for Question 2 and Question 3 responses for each student determined that all 25 students gave responses that were coded as “positive change.” Sample responses from individual students for Questions 2 and 3 are provided below:

- **Question 2:** “I didn’t really like it all that much…”
  **Question 3:** “Now I’m interested in it a lot….I found it was really exciting because of just the things that you can do with science. There are no limitations to what you can do and how you can do it.”

- **Question 2:** “I had no interest in science, I didn’t know anything.”
  **Question 3:** “Definitely positive, I think it is really interesting. There’s so much to learn and the way J has taught it, makes it easy for people who haven’t known anything about science to put science forward for children to understand it.”

- **Question 2:** “I didn’t really want to do it that much.”
  **Question 3:** “By the way that J conducted herself within the lecture made it interesting. The facts that she told us. She explained how to explain it to the children for when we were teachers. And the same in the tutes, she gave us different experiments we could do with the kids. It was fun to go to and I enjoyed going… I actually enjoy it now.”

- **Question 2:** “I hated science. I don’t think I had a very good teaching experience with science when I was in school. So I didn’t pay much attention and didn’t like it at all.”
  **Question 3:** “I think it’s definitely accelerated. I’m definitely enjoying it a lot”
more.”

**Question 4:** On a scale of “negative, neutral, positive”, what was your interest in science before the unit?

**Question 5:** On a scale of “negative, neutral, positive” what is your interest in science after the unit?

When coding the responses to Questions 4 and 5, a “positive change” was coded if the response for Question 4 was lower than the response to Question 5. For example, a “negative” response in Question 4 would be followed by a “neutral” or “positive” response for Question 5. Also, a response indicating a change from “positive” to “increased positive” was coded as a “positive change”. A “negative change” could be coded if the response for Question 4 was higher than the response for Question 5. The coding of “no change” could be recorded if there was no difference in the responses for Questions 4 and 5. The comparison of Question 4 and Question 5 responses for each student determined that all 25 students gave responses that were coded as positive change.

**Question 6:** Has there been any change in your behaviour with respect to science since you began the unit?

This question was important because a response about a positive change in behaviour related to science would strengthen the evidence for a positive change in individual interest. Students who have an individual interest in science should be more likely to seek out science-related experiences than students with little or no interest in science.

The responses to this question were coded as either “compatible with a positive
change”, “compatible with no change”, “compatible with a negative change”, or “not clear”. The category “compatible with a positive change” was used when a student either explicitly stated or implied an increase in science-related behaviour. It should be noted that occasionally, some of the other questions in the interview revealed a positive change in behaviour, and these were included as “compatible with a positive change”. The category of “compatible with no change” was for use when a response, either stated or implied, indicated no change in behaviour related to science. The category “compatible with a negative change” was for use when a response was either an implied or stated decrease in science-related behaviour. The category of “not clear” was for use when a response could not otherwise be categorised. For example, if a student suggested a probable future change but could not describe a change in science related behaviour since undertaking the science unit, then it was coded as “not clear”.

The following are examples of responses coded as “compatible with positive change”:

- “My supervisor at one of my jobs, he’s doing a high science degree at the moment and we have a lot of interesting conversations now, especially when we were doing the solar system with J. That would not have happened before.”
- “I talk a lot more about science with my children at home, whereas before I would not talk about science at all really.”
- “I was really interested, and I found myself watching more documentaries in science, reading more things about science.”
- “I’ve just moved house and now we have Foxtel. Now I’m more looking at the
Discovery network and those types of channels. Because now that I have more of a background of how the world works I’m more interested in finding out stuff about it. So, yeah, my interest has increased.”

Twenty-four of the 25 interviewees described a change in behaviour that was coded as “compatible with positive change.” The other student gave a response in Question 6 that was coded as “no change.” In response to Question 6, this student stated, “Yes. I’d probably feel a lot more confident talking to people as well about certain topics.”

Has that happened at all?

“Not as yet. No.”

**Summary of responses for changes in individual interest from Questions 1-6**

Except for the student described in the previous section, each of the other 24 students gave responses to Question 6 that were congruent with the responses to Question 1, and also congruent with the responses to Questions 2-5. Consequently, the interview responses to Questions 1-6 provided evidence that 24 of the 25 interviewees indicated that they had increased their individual interest in science.

One student’s sample of responses to Questions 1-6 is presented below.

**Question 1: Has the unit changed your interest in science?**

Response: “Definitely. Absolutely. I was never interested in science. I had always found it rather boring and confusing. But I found that the lectures and the classroom activities to be really changing it. It was fantastic.”

**Question 2: Before the unit, what was your interest in science?**

Response: “Minimal. I was interested in really spectacular things like electrical
storms but the smallest thing like how a leaf grows wasn’t in my interest, and now it is."

Question 3: What is your interest in science after the unit?
Response: “Much greater. I’m really looking forward to getting into the field of teaching so I can pass on the experience and fun that science can be.”

Question 4: On a scale of “negative, neutral, positive” what was your interest in science before the unit?
Response: “Negative.”

Question 5: On a scale of “negative, neutral, positive” what is your interest in science after the unit?
Response: “Positive.”

Question 6: Has there been any change in your behaviour with respect to science since you began the unit?
Response: “I look things up online mostly. And I’m still an average student, so although I’m really interested I might not be fantastic at science but I have got a much keener interest so I do start to look at things with like analysing it and trying to see through the layers to what’s deeper. And I do like to have science conversations with my boyfriend who is much more advanced in this sort of thing than I am, and it makes me feel good when I can show him up.”

6.4.2 Causes of change in individual interest (Questions 7, 8, and 9)

The purpose of Questions 7, 8, and 9 was to determine the causes of any changes in individual interest in science. Was there a connection between instances of situational interest and individual interest?
**Question 7: Was there anything that happened in the unit that helped increase your interest in science?**

**Question 8: Did that interest you at the time?**

The purpose of Question 7 was to confirm that factors within the unit/course had contributed to increases in individual interest. Responses were coded as either “course factors”, “non-course factors”, or “not clear”. All 24 interviewees who had been categorised as having increased individual interest did describe course factors that they said were responsible for the increase.

The purpose of Question 8 was to verify if the course factors reported by the students had created situational interest. The responses to this question were coded as “positive for situational interest” if students responded with words such as “yes”, “absolutely”, “it did”, “for sure”, and “definitely.” All 24 students responded in this way. No responses were coded as either “negative for situational interest”, or “not clear”. The following are some responses that affirmed an arousal of situational interest after having described something that interested the students in the science unit. Many responses to “Did that interest you at the time?” consisted of a single word “yes”. Some students extended the responses with a brief explanation. Sample responses for Questions 7 and 8 from eight students are listed below.

- **Question 7: Was there anything that happened in the unit that helped increase your interest in science?**
  
  Response: “It felt easier to learn because of the way it was put and the examples and activities that we did felt relevant to what I’ll be doing later. A lot of the activities were targeted towards kids so it would be things that we’ll actually be teaching when we’re out in the classroom. So I think that helped...”
rather than treating us as science students.”

**Question 8: Did that interest you at the time?**

Response: “Yeah. She gave us things that we could use to explain to kids if they had questions. Just that it would be relevant and useful and I wouldn’t just put it in a pile and never use it again.”

- **Question 7: Was there anything that happened in the unit that helped increase your interest in science?**

  Response: “Yes it did. It was interesting how you could give information in a fun way. Not stand up and just say everything. When I understood what she was saying it was nice that I understand the scientific concepts because I never knew I could understand those things. I didn’t know anything before. And now I know a lot. And that makes me want to learn more.”

**Question 8: Did that interest you at the time?**

Response: “Yeah. Because I always thought they were such hard concepts but they’re pretty easy to understand when she was telling you.”

- **Question 7 response:** “I’ve never really done hands on things before. Everything was new to me. I know that some students were straight out of school and possibly may have seen all this stuff, but I came from older style schooling, it was all new. And I’d say oh wow can you do that?”

  **Question 8 response:** “Yes for sure.”

- **Question 7 response:** “The DNA extraction. It was fascinating. I had no idea that you could take something simple like a strawberry, banana and do it in a classroom with kids. It was just so exciting. Like DNA, woah that’s something
that only intellectual people know about. And I just I loved it. I was into it. I wanted to feel it.”

*Question 8 response:* “It was like a light bulb moment where I thought wow this is really interesting and I can understand it. It was something I thought I could never do.”

- *Question 7 response:* “When you’re looking at fossils, your mind is racing at how old they are. Comprehending how old all those things are.”

*Question 8 response:* “Yes. It sparks the interest. It sparks the interest in how do they know what they know. It made me go online to find out some more information.”

- *Question 7 response:* “Like when we did the solar system and she had a foam sphere and she pulled it apart and showed you how the Earth is made up. She had foam examples of the solar system – all your different planets, and also brought in fruit… we had to place them in order of how the planets would fit and the sizes of them. It also gives the kids a visual of how things are set out.”

*Question 8 response:* “Yes, because I know what planets are in the solar system but I always had problems remembering what order they’re in. The way with the fruit you can remember and kind of associate them with the planets. …. once you’ve learnt something and it’s in your head it makes you interested in that subject as well.”

- *Question 7 response:* “The very first day we walked into the classroom, J had all these activities and all these hands-on experiments organised and ready for us. And that was the thing that was like this isn’t going to be one of those
lessons in which we’re going to sit down and read off the board. It’s going to be more hands-on. So in one particular aspect, definitely the hands-on experiment activities were a great stepping stone.”

Question 8 response: “Yes definitely. I was very intrigued and ready to go and do those experiments, but also to think about them and go home and reinforce that knowledge.”

- Question 7 response: “J’s so passionate about it. I don’t think you’d find someone every day that is as passionate as her. In her voice, it’s like she’s got a hundred things that she wants to tell you about this thing. She sounds excited. Engaging the students as well, but how she did that was by her voice, her gestures, bringing things in, inviting people down the front, people put their hands up she acknowledged their point, and explained it.”

Question 8 response: “Yeah. Because she’s so excited about it, it makes you want to come back next week.”

Question 9: Why did that interest you at the time?

The purpose of this question was to identify the sources of situational interest. For example, some students had found that the hands-on activities had aroused their interest, so this question was designed to find out why hands-on activities (and the other factors mentioned by students) had generated situational interest. These responses were coded firstly by using the literal descriptors for sources of situational interest, then when some of these appeared to overlap in meaning they were combined into broader categories. From these codes, the following broad categories were established: successful learning, specific teaching techniques, novelty,
relevance to teaching primary science and to life, and teacher qualities. Each of the 24 students who were coded as having increased individual interest in science described more than one reason for an increase in interest in science. Samples of responses are listed below:

a) Successful learning

- “It’s a little bit of success that I’ve learnt something. Now that I understand it more, I am more interested in it.”
- “Just her way of explaining things was really simple. It wasn’t like a big scientific explanation. It was easy to understand. Yes, because it makes me think I’m not dumb at science, I can do it, and I can understand it and it’s not as hard as I originally thought.”
- “There’s definitely a lot of gratifying feeling in learning, feeling like you have accomplished something when you walk away and I feel that with her course there were a lot of chances to get that feeling. You have to feel success.”
- “Yes. In understanding it more, it helps to spark your imagination a bit and you want to keep on going with it.”

b) Specific teaching techniques

- “Stories about past scientists and their revolutionary ideas and about the responses of society towards them. I found it quite interesting.”
- “The way that she does the lectures is really good. She has really good pictures and not just all text…She talks in depth and she kind of interacts with the students in the lecture theatre. Everyone ask questions and it’s kind of
brainstorming throughout the lecture. It is quite interesting.”

- “And the stories that she told were really interesting. They seemed like a real life story. I enjoy stories and I enjoyed coming to her tutorials because I liked hearing what she had to say.”

- “And the little fun facts that she’d have to the side were interesting. I’d go home and tell my little brother and my little sister something that I’ve learnt.”

- “I think something that always got my interest was how everyday objects can be put in relation to a science lesson. So it doesn’t have to be like the big skeleton that everyone wheels around the classroom. It can be a little fun skeleton kit or she had little rubber skeletons – things that a kid might use as a toy, but you can explain it in a scientific way.”

c) Novelty - Experiences that were surprising, new, and unusual

- “Unusual. Something rare. It helped me to be more interested.”

- “Yes, unusual, I’d never seen it before. Hadn’t thought of that before, something different. Something unusual. Something that as a teacher I think I can use. As far as my students go that could be something that could increase their interest.”

- “The extraction of DNA from strawberries…Because it was different, it was unusual. It wasn’t something I’d ever done before or seen before. I had no concept that it could be done at such a simple level.”

d) Relevance to teaching primary science and to life

- “Teaching me these activities I could use in a classroom. So it was relevant to
what I’m doing.”

- “In the context of becoming a teacher, I can see all the different ways I can present information to the kids like through games, funny stories, and stuff that got me more interested.”

- “Obviously wanting to be a teacher, that’s all I want to do is teach people and show people things. So if it’s something interesting for a child then that makes it relevant for me and makes it interesting for me.”

- “Yes, definitely. If it was science for the sake of science and not geared at all to teaching, then it wouldn’t seem so relevant and I wouldn’t have been so interested and say, I can use this, I can use this. I was more engaged with it and interested.”

**d) Teacher qualities**

- “You don’t really care about it at the start, like we are doing rocks today. But when you see how enthused she is about these rocks you just take an interest.”

- “I don’t understand the psychology behind it, but I guess if someone is excited about something they going to talk about, rather than being boring and mundane, you want to know more because this person is excited.”

- “When somebody is passionate about something and you spend some time around that person it can rub off on you and you take an interest. You can share an interest naturally with people….you are more likely to be interested in them and then you get curious and wonder to yourself why she’s so interested in these rocks.”

- “J’s enthusiasm about it. That made me more interested. Having an animated
Summary of responses linking situational interest with an increase in
individual interest

The 24 students gave responses that provided evidence of situational interest occurring during the science unit precipitating an increase in individual interest in science. The coding for sources of situational interest that caused an increase in interest resulted in the following categories: successful learning, relevance to teaching primary science, novelty, teacher qualities, and specific teaching techniques. The information below presents results of the categories of situational interest that affected individual interest in science.

- The feeling of successful learning and understanding science was reported by 24 (100%) of the students as a cause of an increase in science interest.

- Specific teaching techniques were reported by 24 (100%) of students as a cause of an increase in individual interest.

- The novelty aspect of the teaching techniques to arouse situational interest in science was reported by 22 (92%) students.

- Relevance to teaching primary science and to life causing an increase in interest in science was reported by 19 (79%) of the students.

- Teacher qualities of passion and enthusiasm for teaching science was mentioned by 15 (63%) of the students.

Table 32 presents the sources of situational interest that each student indicated in their responses. As can be seen from the table, each student had reported multiple sources of situational interest that had their changed in interest in science.
Table 32

Sources of Situational Interest Reported by Each Student (n = 24)

<table>
<thead>
<tr>
<th>Student</th>
<th>Successful learning</th>
<th>Specific teaching techniques</th>
<th>Novelty</th>
<th>Relevance to teaching primary science and to life</th>
<th>Teacher qualities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>2</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>3</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>4</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>5</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>6</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>7</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>8</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>9</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>10</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>11</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>12</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>13</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>14</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>15</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>16</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>17</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>18</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>19</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>20</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>21</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>22</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>23</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>24</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Total</td>
<td>24</td>
<td>24</td>
<td>22</td>
<td>19</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>100%</td>
<td>100%</td>
<td>92%</td>
<td>79%</td>
<td>63%</td>
</tr>
</tbody>
</table>

6.4.3 Changes in self-efficacy for teaching science (Questions 10-14)

The purpose of Questions 10-14 was to determine if any change in self-efficacy to teach science had occurred during the science unit. Note that the term “confidence” was used in the interviews in place of the term “self-efficacy” in order
to clarify meaning for the interviewees. These questions asked the same information in different ways to enhance the validity and reliability of the interview data. The coding of the responses occurred in a similar manner to the coding of interest in science, that is, multiple questions were used to obtain data. It was important to establish the extent to which the responses to different questions were congruent. A positive change in self-efficacy was coded when the responses to Question 10 were coded as “compatible with a positive change”, AND when the responses to Questions 11 and 12 were coded as “positive change”, AND the responses to Questions 13 and 14 were coded as “positive change”. Any responses that did not have this degree of congruence were coded as “not clear”. Conversely, a negative change in self-efficacy to teach in science would have been coded when consistent negative responses would have been recorded for Questions 10-14. However, no responses of this type were obtained.

**Question 10: Has the unit changed your confidence to teach science?**

The responses to this question were coded as “compatible with a positive change”, “compatible with no change”, “compatible with a negative change”, or “not clear”. The category “compatible with a positive change” was used when a response was either a stated positive change or an implied positive change even though the student may not have stated it explicitly. The category of “compatible with no change” was for use when a response, either implied or stated, could be interpreted as indicating no change. The category “compatible with a negative change” was for use when a response was either an implied or stated change indicating a decrease in interest as a result of the science unit. The category of “not clear” was for use when a
response could not otherwise be categorised.

The result of the coding process for Question 10 was that all 25 interviewees were coded as “compatible with a positive change.” This number of interviewees ($n = 25$) was different from coding the interviewee numbers ($n = 24$) for Questions 1-9. This was because only 24 interviewees were confirmed as having increased their individual interest in science as a result of situational interest. However, Questions 10-14 collected interviewees’ responses to confidence to teach science. Therefore, all 25 students were included in these data. The following are examples of their responses.

- “Absolutely. I’ve gone from no confidence at all to pretty high confidence. I could walk into a classroom and read something and be able to come up with ideas myself to teach it.”
- “I think it definitely has. Before, I wasn’t necessarily scared of science, but I’d never contemplated how you would teach science. But having seen the way that it was taught and how you can make it really simple and you can make it interesting. And it’s not hard to do that. And you can use simple little experiments or activities to teach that and to keep people interested. I guess it gives me greater confidence to be able to go out there and do it.”
- “It did, definitely. Just the tutorials with J, the different activities she showed us, what is good to teach students, and what makes it easy for them to grasp. Confidence definitely increased.”
- “Heaps. I was overwhelmed to teach science before …but now I have more confidence to do that.”
“Yes, it [confidence] has improved it a lot. I didn’t have any idea before on how to approach it. Having her show us practically all the different games and things, gave me a lot of ideas that I could use in a class.”

**Question 11: What was your confidence to teach science like before the unit?**

**Question 12: What is your confidence to teach science like now after the unit?**

When coding the responses to Questions 11 and 12, a “positive change” was recorded if the response for Question 11 indicated a lower interest in science than the response for Question 12. Either response could be explicitly stated or implied. A “negative change” was to be coded if the response for Question 11 described a higher interest in science than the response for Question 12. The coding of “no change” was to be recorded if there was no difference in the interest described for both Questions 11 and 12. The category of “not clear” was to result from responses that could not be categorised.

The comparison of coding for Question 11 and Question 12 responses determined that all 25 students gave responses that were coded as “positive change.” Sample responses for Questions 11 and 12 from individual students are listed below:

- **Question 11:** “Not confident at all. I would have stayed very far away from that and given it to the casual teachers.”

- **Question 12:** “Highly positive. I definitely feel I’d be able to walk into a classroom and not even having a lesson plan there but be able to say ‘I’m going to teach about this’, and go ‘we’re going to learn this today guys’. And off we go.”
Question 11: “I was dreading it. It [teaching primary science] just seemed so daunting.”

Question 12: “I’m really looking forward to it. It’s completely turned me around now, because I can make it exciting and actually teach something rather than the students just sitting there with blank looks on their faces. I’m actually champing at the bit to get put into schools so I can start teaching it.”

Question 11: “I would be avoiding it like the plague.”

Question 12: “Huge amount more confident. All teachers need to do some research before they teach, and I really think now I can do it.”

Question 13: On a scale of positive, neutral and negative before the unit your confidence to teach science would have been?

Question 14: On a scale of positive, neutral and negative after the unit, where would your confidence to teach science be now?

When coding the responses to Questions 13 and 14, a “positive change” was coded if the response for Question 13 was lower than the response to Question 14. For example, a “negative” response in Question 13 would be followed by a “neutral” or “positive” response for Question 14. A “negative change” was to be coded if the response for Question 13 was higher than the response for Question 14. The coding of “no change” was to be recorded if there was no difference in the responses for Questions 13 and 14. The category of “not clear” was to result from responses that could not otherwise be categorised.

The comparison of Questions 13 and 14 showed that all 25 students gave responses that were coded as positive change. Relevant data for these changes are presented in Table 33.
Table 33

*Change in Confidence from Before the Science Unit to After the Science Unit*

<table>
<thead>
<tr>
<th>Confidence before the science unit</th>
<th>Confidence after the science unit</th>
<th>Number of students ($n = 25$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Negative</td>
<td>Positive</td>
<td>15</td>
</tr>
<tr>
<td>Neutral</td>
<td>Positive</td>
<td>5</td>
</tr>
<tr>
<td>Negative</td>
<td>Neutral-positive</td>
<td>1</td>
</tr>
<tr>
<td>Negative</td>
<td>Neutral</td>
<td>4</td>
</tr>
</tbody>
</table>

**Summary of responses for change in teaching confidence**

According to the criteria for establishing congruence in this study, a positive change in self-efficacy for science teaching was to be recorded if the responses to Questions 11 and 12 were coded as “positive change” AND the responses to Questions 13 and 14 were coded as “positive change” AND the responses to Question 10 was coded as compatible with a positive change. According to this criterion, all students ($n = 25$) were coded as having experienced a positive change in self-efficacy to teach science.

One student’s sample of responses to Questions 10-14 is presented below.

*Question 10: Has the unit changed your confidence to teach science?*

Response: “Heaps. I was overwhelmed to teach science before and of course I still have so much research to do and I couldn’t teach science straight away, but now I have more confidence to do that. I’ve got ideas and things, yes.

*Question 11: What was your confidence to teach science like before the unit?*

Response: Probably zero. Mainly because I didn’t have in-depth knowledge.

*Question 12: What is your confidence to teach science like now after the unit?*

Response: Fairly high. Very close to high.
Question 13: On a scale of positive, neutral and negative before the unit your confidence to teach science would have been?
Response: Probably negative. I wouldn’t have the passion to go out and do it because I’ve not always been really interested in it and I wouldn’t have had the confidence to do it.

Question 14: On a scale of positive, neutral and negative after the unit, where would your confidence to teach science be now?
Response: At the top, positive.

6.4.4 Causes of change in self-efficacy for teaching science

The purpose of Questions 15 and 16 was to confirm whether factors within the science content unit had caused changes in students’ confidence to teach science, and to identify those factors. Note that Questions 15 and 16 were both worded in a way that implied that factors within the course had changed their confidence. However, it is unlikely that the wording led to biased responses. The students had already explained in their previous responses that it was the science unit that had changed their confidence. Questions 15 and 16 were analysed together because they asked the same thing in a slightly different way.

Question 15: What happened in the unit that helped to make you more confident to teach science?

Question 16: Did that help to increase your confidence in science?

Many students described more than one cause of a positive change in confidence to teach science. The following broad categories were created: learning how to teach primary science, understanding background knowledge, and teacher
qualities of enthusiasm and passion for teaching science. Samples of responses are listed below:

a) Learning how to teach primary science

The broad category was created from students’ responses that referred to gaining confidence from learning how to teach science to children in the primary classroom. It should be noted that this unit was not intended to teach students how to teach science, but the responses from the students indicated that they had acquired knowledge about teaching by watching it being modelled by the tutor.

- “From seeing J teach, I can use her as a role model and be able to be enthusiastic and she’s helped me understand a lot of key concepts, and I feel much more confident in teaching.”

- “Yes. I do feel more confident as a result of being in this course having got all of these new ideas and observed J in practice. Her actual example of teaching doing the tutes is like an example of teaching I can emulate in my classroom. I’ve got some sort of mental image how I would be standing in the classroom teaching a lesson on science because I have actually been in that lesson, looking at J teach.”

- “I feel a lot more confident now knowing the ways to go about teaching science.”

- “There’s so much to know, but this course just pulled out what was relevant to teaching primary kids. So I didn’t have to view it as a whole big field that I didn’t know enough about. If I can pick out certain things that are relevant to teaching primary school kids and honing my skills on that then therefore I feel
confident to teach science.”

- “Probably because it showed me that science could be fun and engaging and because it’s fun and engaging it will be easier to teach…when I do come to teach them I guess I’ll be more confident because I’m better equipped to teach them. I would be delivering more engaging lessons. So, then I can be more confident that I will succeed as a science teacher.”

- “Yeah. I know kids love hands-on things. And once again the tutorials, using simple everyday kind of things, to show scientific concepts to kids. That increased my confidence.”

**b) Understanding the background knowledge**

This category was used when students stated that understanding the science content increased their confidence.

- “I have a lot more confidence to teach science because of that background knowledge I learned from this course and that by bringing enthusiasm and positiveness and resources and interesting ways to learn I think I can teach it successfully.”

- “I definitely have more of an interest now than what I did, and so I have a lot more confidence to teach science because of that background knowledge I learned from this course.”

- “If you are going to have confidence to teach a class, you going to have to know what it is that you were talking about. So I have learned from someone who knows what they are teaching.”

- “She broke down science into simpler terms.”
“Now, because I have a deeper understanding, I feel more confident to teach the science.”

c) Teacher qualities

Responses were assigned to this category if the interviewees implied that qualities of passion and enthusiasm exhibited by the teacher had increased their self-efficacy for teaching science.

- “Yes. Half of it would be J’s presence, like being enthusiastic.”
- “Yeah, … also just seeing J as not being the super science geek, but being this ordinary woman who loves and is really passionate about science, and just teaching it out of that passion. J being real about it and having a passion for it has been really good for building my confidence to teach.”

Summary of Questions 15 and 16

For Questions 15 and 16, responses confirmed that a positive change in self-efficacy to teach science had occurred. Some students provided more than one cause of an increase in their confidence. Table 34 presents the results of coding for causes of a change in science teaching confidence. The table shows that the two major causes of an increase in self-efficacy to teach science were learning how to teach primary science and understanding background knowledge.
Table 34

*Causes of Change in Self-efficacy to Teach Science for Each Participant (n = 25)*

<table>
<thead>
<tr>
<th>Student</th>
<th>Learning how to teach primary science</th>
<th>Understanding the background knowledge</th>
<th>Teacher qualities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>3</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>7</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>8</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>9</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>10</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>11</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>12</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>13</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>14</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>15</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>16</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>17</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>18</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>19</td>
<td>✓</td>
<td>-</td>
<td>✓</td>
</tr>
<tr>
<td>20</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>21</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>22</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>23</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>24</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>25</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>25</td>
<td>24</td>
<td>7</td>
</tr>
<tr>
<td>Percentage</td>
<td>100%</td>
<td>96%</td>
<td>28%</td>
</tr>
</tbody>
</table>

### 6.5 Summary of Chapter 6

The purpose of this chapter was to present analyses of the qualitative data. Was there evidence of situational interest in science and was there evidence of a link between situational interest and an increase in individual interest in science and an increase in self-efficacy to teach science?
Did situational interest occur?

From responses to Questionnaire 1, it was established that situational interest had been aroused. From responses to the interviews, 100% of the participants gave responses that confirmed situational interest arousal had occurred during the science unit.

Sources of situational interest

The sources of situational interest that emerged from participants’ responses in Questionnaire 1 were specific teaching techniques, relevance to teaching primary science, learning science, novelty, teacher qualities (such as enthusiasm and passion), physical activity, and social interaction. The sources of situational interest that emerged from participants’ responses during the interview successful learning, specific teaching techniques, novelty, relevance to teaching primary science and to life, and teacher qualities of enthusiasm and passion for teaching science.

Did individual interest in science increase?

From Questionnaire 2, (Did you change your interest in science?) 91% of the participants ($n = 205$) expressed an increase in individual interest in science. No participants expressed a decrease in individual interest in science.

From the interviews, 96% of interviewees indicated that their interest in science had increased. Responses included examples of science-related activities that verified the positive change in interest in science, for example, watching science documentaries, reading science articles, and talking more about science with other people.
Sources of increases in individual interest

Responses to Questionnaire 2 identified the following causes for change in individual interest in science: specific teaching techniques, relevance to teaching primary science, teacher qualities, learning, and novelty.

Did self-efficacy to teach science increase?

All the students interviewed indicated that their self-efficacy to teach science had increased.

Sources of self-efficacy to teach science

Reasons given by interviewees for increases in self-efficacy to teach science included learning how to teach primary science, understanding the background knowledge, and teacher qualities. All interviewees indicated that learning how to teach primary science (learning science content plus learning how to teach that content) had increased their self-efficacy to teach science.
Chapter 7
Discussion

7.1 Introduction

This chapter reviews the findings of the study, compares its findings to those reported in the literature, and presents the limitations of the study. The discussion of the findings has been organised according to the research questions of the study.

Research Question 1: Can situational interest be successfully aroused during a science content unit for primary teacher education students, and if so, how does this occur?

Research Question 2: Can strategies designed to generate situational interest enhance preservice primary teachers’ long-term individual interest in science?

Research Question 3: Can self-efficacy for teaching science be enhanced by use of the strategies designed to arouse situational interest?

The discussion in relation to each of these questions is presented in the following three sections. Question 1 is discussed in Section 7.2. Question 2 is discussed in Section 7.3. Question 3 is discussed in Section 7.4. Limitations of the study are explained in Section 7.5.

7.2 Research Question 1: Can situational interest be successfully aroused during a science content unit for primary teacher education students, and if so, how does this occur?

This question will be answered in two parts: was there evidence that situational
interest was aroused, and if it was, what was the source of situational interest?

7.2.1 Was situational interest aroused?

Three sources of data were used to gain evidence for the arousal of situational interest in the science unit. They were Questionnaire 1 (which recorded responses about the generation of interest in tutorials), interview Question 8 (“Did that interest you at the time?”), and Survey 4 (which rated the level of participants’ interest in the teaching strategies of the science unit). Almost all of the participants who responded to Questionnaire 1 (in Weeks 4, 7, and 9) were categorised as having experienced situational interest, as were all the participants who were interviewed, and all those who completed Survey 4.

According to the written responses for the open-ended Questionnaire 1 administered at the end of Week 4, Week 7 and Week 9 tutorials, an average of 99.2% of the participants who completed the questionnaires reported experiencing situational interest. Similar to the results of Questionnaire 1, Question 8 of the individual interviews (“Did that interest you at the time?”) resulted in all students confirming situational interest had been aroused as a result of something happening in the science unit.

Survey 4 verified that situational interest had been aroused as a result of the teaching techniques used in the science unit. The survey requested participants to rate the level of interest generated by the seven categories of teaching techniques: hands-on activities, demonstrations, science magic, anecdotes, use of toys, analogies, and fun facts. Examples of activities undertaken during the tutorials, representing the various teaching techniques, were provided in the survey. Every participant indicated
they experienced situational interest in a number of categories. Many participants indicated situational interest in all categories of teaching techniques.

The high number of positive responses in Questionnaire 1, individual interviews, and Survey 4 indicates that it is possible to generate situational interest in a science content unit for preservice primary teachers. This was a significant finding because, prior to the collection of Questionnaire 1 data, analyses of the pretest interest in sciences surveys (Survey 1 and Survey 2) had demonstrated low individual interest in science for most participants. It is noteworthy that situational interest was aroused in students in spite of their low initial interest in science.

This finding that situational interest can be generated in study participants is consistent with other studies. For example, the study of Dohn et al. (2009) resulted in situational interest being reported in an undergraduate zoophysiology course from use of teaching strategies. The biology studies of Dohn (2011a, 2011b) resulted in all students experiencing situational interest during field trips to the zoo and the aquarium. Palmer (2009) found situational interest had been aroused in the majority of the grade nine students participating in his science study.

7.2.2 Why was situational interest aroused?

Responses to Questionnaire 1 and interview Question 9 (“Why did that interest you at the time?”), as well as the quantitative data in Survey 4, provided evidence for why situational interest was aroused in the science content unit.

Situational interest was aroused through the use of the teaching techniques of hands-on activities, demonstrations, science magic, anecdotes, use of toys, analogies, and fun facts. Other sources of the situational interest coded in the questionnaire and
interview responses included relevance to teaching primary science, learning, novelty, teacher qualities, physical activity, and social interaction. The specific teaching techniques and other sources of situational interest are explained below.

Specific teaching techniques that aroused situational interest

Evidence for specific teaching techniques as triggers of situational interest was first determined from the three administrations of Questionnaire 1. These teaching techniques included hands-on activities, demonstrations, anecdotes and stories, analogies, fun facts, and toy use. However, responses about science magic were not found in Week 7 and Week 9 Questionnaire 1 data because science magic was not included in the tutorial activities.

The main categories of teaching techniques extracted from coded verbatim responses are presented below, including some examples of activities included in responses to Questionnaire 1 and the individual interview. The latter responses contained examples of the teaching techniques from the wide range used in tutorials and lectures, not just those related to the Questionnaire 1 tutorials.

Hands-on activities were strategies that allowed students personally to manipulate materials in practical or experimental tasks (Bergin, 1999; Dohn, 2011a; Mitchell, 1993; Nieswandt, 2007; Palmer, 2009). An example of an activity that all students reported as arousing situational interest involved a hands-on activity to explain that astronauts are weightless because of free-falling in space, not because of the absence of gravity. Students dropped a foam cup with a hole on the side (thumb over the hole) filled with water from a height. This showed that when the cup was
falling, the water inside, being weightless, did not flow out of the hole as it would have when stationary. Other hands-on activities were launching Alka-Seltzer film canister rockets to simulate Newton’s Third Law of Motion. The natural selection group activity involved birds on an isolated island competing for the same food. The birds had differing beaks of pegs, spoons, forks, and chop sticks. The aim was to investigate which bird beaks were most successful in catching food of beans. This would demonstrate natural selection of the birds over time because of successful competition for food.

*Demonstrations* in this study were novel techniques conducted by the teacher to illustrate an experimental skill, to visually aid a scientific concept, to show a surprising result, or to show a real life connection (Nieswandt, 2007; Palmer, 2001). One such activity involved the extraction of DNA from strawberries using everyday materials. This was a demonstration linked to scientists searching for DNA if life were discovered beyond Earth on another planet such as Mars.

Some other demonstrations involved demonstrating the inefficiency of the brain to interpret information collected by the eyes when observing optical illusions. The surprising ability of a flexible straw easily passing right through a raw potato was designed to show that a very small, fast moving space rock could cause severe damage to a spacecraft. To demonstrate inertia, a coin had to be removed from the bottom of a pile of coins without manually moving the upper coins of the pile.

*Anecdotes* and stories connected the science to real life experiences of the teacher and real life applications of the science to complement information presented
in lectures and tutorials (Dohn, 2011b; Martin & Brouwer, 1991; Palmer, 2004b; Teichmann, 2008). Most participants’ responses about anecdotes referred to hearing real life stories and the teacher’s professional experiences. Other stories mentioned in the questionnaire and interview responses were about past scientists, their revolutionary ideas, and the responses of society towards them at the time. Stories about fossils and dinosaurs also were mentioned.

**Analogies** were used to stimulate situational interest by visual and verbally expressed comparisons of abstract science concepts with something familiar in everyday life (Treagust et al., 1996). Examples of analogies in participant responses included modelling the Solar System with fruit and vegetables, modelling the distance of the Moon from Earth with scale-size spheres and a rope to scale for distance to challenge the misconception that the Moon was much closer than it is, and the visual animation of 15 buses filled with hundreds and thousands (cake sprinkles as an analogy for the number of stars in a galaxy of 200 billion stars in the universe. Analogies for teaching about the Universe were successful because they enabled a better understanding of difficult abstract concepts.

**Fun science facts** were snippets of interesting information that complemented the main ideas of science being taught (Palmer, 2004a). Some fun facts included in participant responses described how astronauts cope with bathing, using the toilet, eating, sleeping, and cleaning of hair and teeth while in space, as well as the recycling of urine aboard the International Space Station for water consumption. Another fun fact referred to extremophiles called snottites that hang from the ceilings
of caves of sulfuric acid environments. These colonies of bacteria are protected by mucus that appears similar to mucus running from the nose.

*Science magic* activities were designed to explain science concepts in a mysterious way to create a sense of wonder and surprise (Kuhn et al., 2008). While it could be argued that the science magic activities in fact were demonstrations, they were designed to look like magic tricks to maximise attention, to be puzzling, to stimulate curiosity and amazement, and to promote social interaction by discussion about possible reasons for the unexpected results. All the science magic activities were easy to perform and only required common materials from the school or home. Interestingly, science magic was reported as a major trigger of situational interest even though these activities were limited in use. Yet science magic activities have not been reported as sources of situational interest in the literature. The situational interest aroused by science magic activities was also confirmed in Survey 4 where they were rated second highest for situational interest.

Examples of science magic activities mentioned by participants included: “Willing” a coin sitting on top of an empty bottle to move to illustrate the convection of heated air caused by the hands wrapped around the bottle; disappearing water in a cup (sodium polyacrylate from a disposable nappy or diaper trick) highlighted the use of the maximum absorbency garment that astronauts wear during launch, reentry and spacewalks; after the teacher announced she had a “magic finger” (secretly covered with detergent), her finger gently touched the surface of milk with drops of a variety of food colourings on top. Her “magic finger” created a continuing variety of swirling food colours on the surface of the milk from the detergent reduction of
surface tension on the surface of the milk. Similarly, her “magic finger” caused ground pepper sprinkled on water and bread clip boats magically to move across the surface of water to show that detergent reduces surface tension.

*Toys* were intended to demonstrate scientific concepts in a simple and novel way (Tytler, 2002). The toys were inexpensive examples of those owned or recognised by children. Hence, they could be relevant to future use in primary classrooms. While research has indicated that science-based toys can improve the understanding of science concepts (O’Brien, 1993; Taylor, Williams, Sarquis, & Poth, 1990), no research has been undertaken to investigate toys as a source of situational interest, especially for preservice primary teachers. Similar to science magic, the participants’ reported levels of interest in Survey 4 for toys was high.

Some examples of toys used for explaining scientific concepts included a pair of “rattle snake” magnets to investigate magnetic properties. As they were thrown upwards together they created the typical sound of a rattle snake, a result of magnetic attraction. Solar powered grasshoppers and cockroaches demonstrated the energy change from solar energy to electrical energy to provide power for kinetic energy of movement. Small plastic frogs were used to demonstrate how a finger pushing down on the frog’s back increased the toy’s elastic potential energy which was immediately converted to kinetic energy of the jumping motion when the finger was removed. A wand, a toy Van der Graaff generator, called a “Fun Fly Stick™”, demonstrated repulsion because of static electricity. Light-weight metallic shapes float away from the wand, after they were originally placed on the wand before charging, due to the same static charges.
Teaching techniques as sources of situational interest

The teaching techniques of the present study that were designed as sources of situational interest also produced situational interest in other studies. This is additional evidence for the reliability of the results and, in particular, for the identification of the sources of situational interest. For example, within the domain of science, Palmer (2004b) identified hands-on activities, personal anecdotes and science trivia (fun facts) as sources of situational interest in his study with trainee primary teachers undertaking a science methods course. Situational interest was also generated as a result of hands-on activities during field trips for biology studies with 12th grade students to an aquarium and zoo (Dohn, 2011a, 2011b). Nieswandt (2007) included hands-on activities and demonstrations for situational interest arousal in her chemistry study. Analogies were used by Bennett-Clarke (2005) to stimulate situational interest for at-risk students in biology.

However, science magic and toy activities have not been previously reported as sources of situational interest. Toys may have been used in other studies for enhancing inservice and preservice primary teachers’ knowledge of science, lesson preparation, and enjoyment of science (Meiring, 2010; O’Brien, 1993; Taylor, Williams, Sarquis, & Poth, 1990) but not explicitly as a trigger of situational interest. Yet, the responses to Questionnaire 1 and the interviews indicated situational interest from these activities. Also, there were high mean scores in Survey 4 for both science magic and the use of toys.

Materials and procedures for science magic and toys were simple. Each science magic activity was easy to perform with common, inexpensive materials. The toys
were inexpensive and familiar to children.

**Other causes of situational interest**

Responses to Questionnaire 1 and interview Question 9 provided evidence for the situational interest from other sources including *relevance to teaching primary science, learning, novelty, teacher qualities, social interaction, and physical activity.* The only differences between the Questionnaire 1 and interview responses were the absence of references to physical activity and social interaction as sources of situational interest. However, these sources were also low in proportion in the Questionnaire 1 responses so they were probably less important. These causes of situational interest are explained below. And, as noted earlier, there was overlap among these activities.

*Relevance to teaching primary science* referred to a perception of the value of the teaching techniques in meeting participants’ plans for a future career (Chen & Darst, 2002; Dohn et al., 2009; Mitchell, 1993; Nieswandt, 2007; Palmer, 2004b). This was one of the two most common sources of situational interest. Coding of the questionnaire and interview responses provided three main reasons for why the situational interest created relevance. One reason referred to future careers for teaching primary science. Classroom applications for specific teaching techniques were frequently reported as a reason. Usefulness of everyday materials was mentioned frequently because participants would be teaching in primary classrooms which usually lack specialised scientific equipment. Also, during the interviews, there were a small number of responses about relevance for the family, for example,
being a parent and wanting to answer children’s questions. One student explained that the activity involving the ear in the tutorial about “The Human Body” was relevant because a family member was in hospital with a middle ear infection.

Identifying relevance as a source of situational interest in this study is in agreement with other studies. Personal relevance was linked with situational interest in the chemistry study of Nieswandt (2007). The science study of Palmer (2004b) confirmed a positive correlation between situational interest of the teaching strategies and meaningfulness (or relevance) of learning how to teach primary science. Morgan’s (2010) study also showed a link between situational interest and relevance.

Hulleman and Harackiewicz (2009) asked high school science students to write short pieces several times during the semester. Half the students (randomly selected) were asked to summarise what they had learned in their science classes. The other students were asked to write about the usefulness of the science they were learning, particularly the relevance to their own lives. At the end of the science classes, the students who wrote about the relevance of the science topics reported more interest in science and achieved higher grades than the students who summarised the science lessons. For the current study, relevance was tied to participants’ desire to understand scientific concepts and to see how to demonstrate these concepts to young children.

*Learning* in this study occurred if participants indicated that they had understood a scientific concept or they had learned how to teach science. Similarly to relevance, learning was noted as a common cause of situational interest. A number of participants who were interviewed described why learning generated situational interest. A pleasurable feeling of success had been sparked by understanding the
science and learning how to teach it. Other studies have found a relationship between situational interest and learning. Palmer’s (2004b, 2009) studies found that successful learning experiences could generate situational interest amongst preservice primary teachers and grade nine science students. Learning science concepts was shown to a source of situational interest in the field studies of Dohn (2011a, 2011b).

Teacher qualities in this study were coded when responses indicated that the qualities of the teacher, especially enthusiasm and passion, had generated interest. This was an unexpected finding because teacher qualities have not previously been reported in situational interest studies, although it is well known that teacher enthusiasm is an attribute of an effective teacher (Kunter, Frenzel, Nagy, Baumert, & Pekrun, 2011. Kunter et al. (2011) investigated two dimensions of teacher enthusiasm, enthusiasm for teaching and enthusiasm for the subject. By comparing teacher self-reports with student reports about teacher enthusiasm, Kunter et al. (2011) found that the two kinds of enthusiasm were distinct variables. However, both were important for student learning. In a study involving university students, Patrick, Hilsey, and Kempler (2000) investigated teacher behaviours that could increase students’ intrinsic motivation to learn. The authors demonstrated that students have greater interest, curiosity and excitement for learning when the teacher is enthusiastic. Archer (2000) interviewed primary teachers about their beliefs for successful teaching. “The teachers agreed that teachers’ enthusiasm was infectious. If teachers appeared excited about what they were doing, then students would show more interest in their work” (Archer, 2000, p13).
Novelty used in this study was designed to generate situational interest by providing variety, or something new, unusual, or surprising, or by allowing participants to discover that something they believed to be true was in fact a misconception (Bergin, 1999; Palmer, 2007). Novelty emerged in a wide range of questionnaire and interview responses referring to science magic, demonstrations, experiments, hands-on activities, unusual artefacts, personal anecdotes, surprising stories, fun facts, simple explanations, new information, analogies, models, science puzzles, and games.

Novelty as a source of situational interest appeared in other studies such as Dohn (2011a, 2011b). Dohn determined that a source of situational interest in his zoo and aquarium visits was novelty. Palmer (2009) found that novelty was the major source of situational interest in his study. It was aroused by new learning experiences, surprise, suspense and variety. Chen and Darst (2002) demonstrated novelty in the learning of new physical education skills.

Physical activity was noted as a source of situational interest if a participant’s response implied that physically manipulating resources or playing interactive games to learn a science concept, or actively moving within or outside the classroom had generated interest. This was one of the less common sources of situational interest according to the data from Questionnaire 1 and it was not indicated as a source during interviews. Physical activity as a source of situational interest has emerged in other studies. For example, Palmer (2009) found that physical activity was a source of situational interest in the science classroom with grade nine students. Mitchell (1993) found that the physical involvement in group work was a source of situational
interest in the mathematics classroom.

*Social interaction* was considered as a source of situational interest in Questionnaire 1 if a response noted that interaction with the tutor or with other students or with tutorial resources had generated interest. This was the least common source of situational interest identified in this study and was not indicated as a source during interviews. In previous studies, social interaction was found to be a source of situational interest as a result of discussion and group work (Chen & Darst, 2002; Del Favero et al., 2007; Hidi & Renninger, 2006; Mitchell, 1993; Nieswandt, 2007; Palmer, 2009). For example, Del Favero et al. (2007) found the social interaction of discussion generated situational interest with eighth grade students. However, as may have occurred with the current study, Dohn et al. (2009) argued that social interaction had less impact on situational interest as participants got older.

### 7.2.3 Summary of findings for Research Question 1

In summary, for Research Question 1 of this study, triangulation of the data sources indicated an acceptable level of validity and reliability of the findings. The sources of situational interest that emerged from Questionnaire 1 (administered three times) were similar to those obtained from the interview transcripts and similar to those obtained in Survey 4. The exceptions were physical activity and social interaction. These emerged as minor sources of situational interest in Questionnaire 1 but they were not mentioned in the interview transcripts.
7.3 Research Question 2: Can strategies designed to generate situational interest enhance preservice primary teachers’ long-term individual interest in science?

This question will be answered in two parts because it is necessary first to establish whether or not individual interest in science was increased, and if there is evidence of an increase, what factors appear to be associated with this increase.

7.3.1 Was individual interest in science increased?

Evidence for change in students’ individual interest in science was obtained from four sources: Survey 1 (a list of science topics); Survey 2 (participants’ reports of involvement in science-related activities); Questionnaire 2 (participants’ self-evaluations of change in interest in science over the science unit); and interview Questions 1-6 which asked participants if any change in individual interest had occurred during the science unit.

Surveys 1 and 2 were administered in the pretest and immediate posttest. Questionnaire 2 and the interviews were administered at the end of the unit only. In addition, it was also important to measure students’ reported interest in science after a delay period because individual interest is conceptualised as a relatively stable phenomenon. Hence, information about the stability of change in interest in science was obtained from a delayed posttest (10 months after the end of the unit). Survey 1 showed that student interest in a range of science topics had increased substantially from the pretest to the immediate posttest. There was a small but statistically significant decrease in interest in science topics ten months after the end of the science unit, but the interest remained significantly higher than it had been at the
An additional finding from Survey 1 was that student interest had increased for all topics, not just for the topics that were taught during the unit. This suggests that a broad interest in science had been generated. This positive result with respect to increased interest in science topics, both taught and not taught, has not been demonstrated in other studies.

While different from the current study in method and results, one study had examined the possibility of increasing individual interest in science topics. Kerger et al. (2011) investigated if “feminised” biology and physics topic contexts could trigger and maintain situational interest and thereby increase girls’ individual interest in science. The authors used an interest survey with 40 Likert-style items to compare girls’ and boys’ interest in the “feminine” science topics with the more “masculine” or standard topic contexts. They found that the girls had substantially increased their interest in the science topics when presented within a “feminine” physics context. Conversely, the boys experienced decreases in interest in the feminised physics topics but were significantly higher for the standard or masculine context topics.

The results of Survey 2, participants’ reports of individual interest in science-related activities, also showed statistically significant increases from the pretest to the immediate posttest. There was a small but statistically significant decrease in interest from the immediate posttest to the delayed posttest. However, reported interest at the delayed posttest remained significantly higher than it was at the pretest. After the delay period of ten months, participants reported that they were still taking an interest in science news, talking about science with friends, watching
science shows on television, and discussing science with their families.

It is not surprising that there would be some lessening of individual interest in science ten months after the completion of the science unit. No doubt participants already had individual interest in a variety of activities. Once the stimulation of the science unit has passed, some participants would have returned to other more established individual interests. What would have been the results if Survey 2 had been administered a fourth time ten months later? One might expect there would be another decrease. A more pertinent question might be: would participants’ reported individual interest in science return to their pretest level? Given the data reported in the study, in particular, the strength of the increase in individual interest across the semester, the researcher remains confident that individual interest in science would remain elevated, at least for some of the participants in the study.

Survey 2, developed for the present study, demonstrated strong statistical reliability on three occasions. As noted earlier, Survey 1 was not a scale as such, rather a list of science topics. However, it was notable that a similar pattern of results emerged for Survey 1 and Survey 2, that is, a pronounced increase from pretest to immediate posttest, and a slight but statistically significant fall from immediate posttest to delayed posttest. The first item of Questionnaire 2 recorded change in individual interest as a result of the science unit. The responses indicated that almost all of the students who responded indicated a positive change in their interest in science. These results support the results of Survey 1, Survey 2, and the interviews, in pointing to an increase in interest in science over the period of the science unit.

The interview Questions 1-6 provided evidence that interest in science had
moved from negative or neutral to positive for all students interviewed, except one. This student could not confirm a change in any science-related behaviour. The other students described new activities such as watching science documentaries, reading science articles, and talking more about science with other people as indicators of increased interest in science-related activities. It should be noted that the students who agreed to be interviewed about their experiences during the science unit were likely to be students who particularly enjoyed the unit. Students who were less positive about the science unit would be less likely to volunteer for an interview.

These findings for Research Question 2 correspond in some respects to the findings of other researchers who have examined changes in individual interest. For example, Mitchell and Gilson (1997) used their Interest Survey of forty-five items administered as a pretest and posttest (sixteen weeks apart) and found significant increases in individual interest in mathematics. Mitchell (1997) used the Interest Survey in pretest and posttest measures in statistics classrooms to confirm that individual interest had increased for students. In their longitudinal study, Harackiewicz et al. (2000) used a thirteen-item questionnaire administered after two examinations and just before the final examination to show a significant increase in students’ individual interest in psychology. This interest was confirmed by subsequent enrolment to study and complete other psychology courses. Del Favero et al. (2007) used a twenty-one item true or false questionnaire to conclude that significant gains in individual interest in history had occurred and were maintained for students. The present study adds to these findings. The use of a delayed posttest in the current study to look for evidence of on-going interest in science provides a
strong research design from which to draw conclusions.

7.3.2 What caused the increase in individual interest?

Evidence for the causes of the increase in individual interest came from two sources. First, participants’ responses to the open-ended item in Questionnaire 2 (“What caused a change, or not, in your interest in science? Please explain as fully as possible”) which was administered at the end of the unit. Second, evidence was provided from responses in the interviews in which students had been asked the question “Was there anything that happened in the unit that helped increase your interest in science?” (interview Question 7).

Analysis of the responses to the open-ended item in Questionnaire 2 showed that specific teaching techniques, such as the use of science toys, hands-on activities, experiments, demonstrations, stories, science magic, analogies, and fun facts had helped to increase the students’ interest in science. In addition, students provided other reasons such as relevance to teaching primary science, learning, novelty, and teacher qualities. Importantly, these were the same factors that were identified as sources of situational interest (see Section 7.2.2 above).

According to the interview transcripts, all twenty-four interviewees who had been categorised as having increased their interest in science referred to course factors as the reason. These factors included teaching techniques such as the use of science toys, hands-on activities, experiments, stories, science magic, fun facts, and demonstrations, as well as other reasons such as successful learning, relevance to teaching primary science, novelty, and teacher qualities. Once again, these reasons were the same as those identified as sources of situational interest. Thus, the
evidence suggests that regular exposure to sources of situational interest can lead to increases in individual interest.

This evidence is broadly supportive of other studies that have identified a positive relationship between situational interest and individual interest, in spite of the use of different methodologies. Mitchell and Gilson (1997) found that mathematics classrooms high in situational interest tended to also have increases in students’ individual interest. Mitchell (1997) used the same methodology for data collection and analysis as Mitchell and Gilson (1997) to argue that high situational interest significantly increased individual interest, especially for students who had low pretest individual interest scores in the statistics classroom. Harackiewicz et al. (2000) found students’ high ratings of enjoyment of the lectures and of the instructors in a psychology course increased their individual interest. Harackiewicz et al. (2008) extended the study of Harackiewicz et al. (2000). They found that participants’ mastery goals (the goal to understand the subject matter) were sources of situational interest that promoted individual interest over the course of an introductory psychology course and then over the following seven semesters. Del Favero et al. (2007) found that situational interest aroused from the instructional strategies in the history classroom resulted in an increase in individual interest for all students. Additionally, in a study in physical education, Chen and Darst (2002) demonstrated an association between high situational interest and high individual interest especially for students with a high level of skills.

The present study added to these studies because it used not only a pretest and immediate posttest but also a delayed posttest, carried out ten months after the
science unit. This provided evidence that individual interest in science was a long-term phenomenon, at least for some students. This finding supports Hidi and Renninger’s (2006) model of a final stage of long-lasting individual interest.

7.3.3 Summary of the findings for Research Question 2

In summary, for Research Question 2, the evidence suggests that individual interest was increased during the science unit, and that those increases were reasonably stable over the delay period, at least for some participants. The high degree of similarity among the different data sources indicates that this finding can be made with an acceptable level of validity and reliability for the participants in this study. It is possible for students to experience substantial increases in individual interest over the relatively short period of time of ten weeks.

Additionally, the interview data were similar to Questionnaire 2 data. This points to an acceptable level of validity and reliability in identifying the reasons why individual interest increased. Comparison of these reasons with the data from Questionnaire 1 indicates that all of these were sources of situational interest. However, unlike Questionnaire 1, the broad categories of social interaction and physical activity were not identified in the interview responses. Therefore, these data suggest that the factors that created situational interest in science (with the exception of physical activity and social interaction) were the same factors that enhanced individual interest in science. The researcher is cautious about claims of causality that repeated experiences of situational interest cause long-term individual interest.

Given the nature of the current research design (no experimental design, no random assignment to groups, no “control” group that did not experience the same teaching
techniques), a causal chain cannot be demonstrated unambiguously. However, the results of the current study do provide support for the argument that the factors that generate situational interest are also the same factors that enhance individual interest.

7.4 Research Question 3: Can self-efficacy for teaching science be enhanced by use of the strategies designed to arouse situational interest?

This research question will be answered in two parts because it is necessary first to establish whether or not self-efficacy was improved, and if so, to identify the factors associated with the improvement.

7.4.1 Was self-efficacy to teach science improved?

Evidence for improvement in science teaching self-efficacy of the participating preservice primary teachers came from two sources of data. First was the analysis of the quantitative data from Survey 3, the STEBI-B instrument (Enochs & Riggs, 1990), followed by responses in the interview Questions 10-14.

Positive changes were found in both of the subscales of the self-efficacy belief instrument (STEBI-B). These increases were evident from the statistically significant differences between the pretest and the immediate posttest. There was no decline in self efficacy from the immediate posttest to the delayed posttest for both subscales: personal science teaching efficacy (PSTE) and science teaching outcome expectancy (STOE).

It was notable that self-efficacy to teach science did not decrease from immediate posttest to the delayed posttest, as occurred for reports of individual interest in science. This result makes sense in that participants’ confidence that they
could teach science in the primary classroom could remain elevated – once confidence was established there would be little reason for it to drop significantly, at least not for some time. Participants’ individual interest in science might be more subject to change.

The STOE scale was not a strong scale in the present study. Its reliability was low for the three times it was administered. As noted earlier, items in the STOE scale focused on teachers in general, that good teaching could help students to learn. The PSTE scale was a stronger scale. The items in the PSTE focused on teachers’ self-efficacy in particular, using the pronoun “I.” According to Mulholland, Dorman, and Odgers (2004), less significant STOE results in comparison to PSTE results could be due to preservice primary teachers’ lack of experience in the classroom. In the present study, most participants were first year university students direct from school and who had not experienced teaching practice in the classroom. Nevertheless, Survey 3 provided evidence of a significant increase in both personal science teaching efficacy and science teaching outcome expectancy using three times of testing.

From other research, it appears that science content courses have not always been effective in enhancing self-efficacy for primary science teaching (Howitt, 2007). The PSTE and STOE results of Morrell and Carroll’s (2003) study in science content classes with preservice primary teachers indicated no significant increase in science teaching efficacy, for the PSTE or the STOE. Morrell and Carroll (2003) argued that increasing science content knowledge does not ensure an increase in preservice primary teachers’ efficacy to teach science. The PSTE and STOE results
in other studies investigating self-efficacy in students undertaking science methods courses have had varying results, possibly due to different interventions (Bleicher & Lindgren, 2005). For example, Morrell and Carroll (2003) gathered PSTE and STOE data with pre and post surveys in science methods classes in the same study described above and demonstrated a significant increase in PSTE but not STOE. Bursal (2012) showed a significant gain in the PSTE (STOE was not included) from use of a pretest and a posttest for preservice primary teachers in a science methods courses. Possible reasons for these different findings are presented in the following section.

The interview transcripts showed that all these participants indicated a positive change in science teaching self-efficacy (interview Question 10). The term “confidence” rather than the more technical term of “self-efficacy” was used in interviews to present questions that could be more easily understood by the interviewees, and so would be more likely to have validity. When asked to describe any change (Questions 11-12), all participants expressed a higher confidence after the science unit than before the science unit. This increase in confidence was further confirmed by participants’ responses of “negative” or “neutral” to Question 13 about their confidence before the science unit, followed by higher “neutral” or “positive” responses to Question 14 for confidence after the science unit.

7.4.2 What caused the increase in self-efficacy to teach science?

Question 3 of this study was to investigate if the same teaching strategies that aroused situational interest could enhance self-efficacy to teach primary science. This section will firstly describe the factors that were found to enhance self-efficacy in
this study. It will then compare these with Bandura’s (1997) sources of efficacy information and the factors that were found to enhance situational interest in the present study.

**Causes of self-efficacy in this study**

Evidence for why self-efficacy to teach science had increased was drawn from the responses to interview Question 15. The interviewees were asked to describe any factors that had caused the increase in their confidence to teach science. The results (presented in Section 6.5.4 of Chapter 6) showed that all interviewees provided more than one reason for their increase in confidence to teach science. The causes were *learning how to teach primary science, understanding the background knowledge* and *teacher qualities* of enthusiasm and passion for teaching science.

First, the main cause of students’ increased confidence, *learning how to teach science*, was coded when students referred to learning how to teach science using techniques such as hands-on activities, experiments with everyday materials, demonstrations, toy use, stories, games, pictures, puzzles, science magic, analogies, and fun facts. These were the techniques that were modelled by the tutor in teaching science, so students learnt these techniques by watching the tutor. The second source of confidence, *understanding the background knowledge*, was used as a category when students stated that learning the science content increased their confidence. The science information presented in the unit was delivered using simple terms and useful analogies, making it easier for participants to understand, thereby promoting a deeper understanding of the concepts. Third, the category of *teacher qualities* was coded when students referred to the tutor’s passion and enthusiasm as increasing
their confidence.

**Causes of self-efficacy compared with Bandura’s sources of self-efficacy**

Bandura (1986) proposed that self-efficacy was not a reflection of individuals’ actual skills but a perception of what they could achieve with the skills they did possess. He described ways in which self-efficacy could be enhanced.

The most powerful source of self-efficacy was enactive mastery, which refers to authentic experiences of mastering a skill. For primary science teaching, an authentic mastery experience would involve actually teaching science to primary children. Unfortunately, this type of experience was not a component of the science content course, and it was not mentioned by any of the interviewees. However, it is possible for students to benefit from other types of mastery experiences. Palmer (2006b) proposed that “cognitive content mastery” could be an alternative source of mastery for self-efficacy for preservice teachers. Cognitive content mastery represents a perception of successful learning, that the preservice teacher can understand the required science knowledge for the classroom. Furthermore, Palmer argued that success in understanding how to teach science in the primary science classroom could be another source of mastery for self-efficacy, which he described as “cognitive pedagogical mastery”.

These forms of mastery appeared in participants’ interview responses, that is, learning how to teach primary science and understanding the background science knowledge. As described previously in this chapter, interview responses for an increase in self-efficacy due to learning how to teach primary science included learning how to explain science content to children using simple techniques such as
hands-on activities and experiments with everyday things. With respect to understanding the background science knowledge, the participants provided interview responses about gaining science understanding mainly because the teacher broke down the science into simpler terms. As a consequence, “cognitive pedagogical mastery” (learning how to teach science) and “cognitive content mastery” (understanding the required science) experiences may have encouraged students to believe that they will be effective in teaching science in the future (Palmer, 2006b).

Bandura’s second source of self-efficacy was vicarious experience, or observing another person perform a task with success. According to Bandura (1997), this type of modelling is especially effective if the person performing the task is a peer of similar ability as the observer. In the science content unit, the students did not model tasks for each other, but the students did have the opportunity to observe an experienced science teacher perform the activity of teaching science. This experience was mentioned in students’ interview responses: observing the teacher showing ways to teach that were applicable to the primary classroom and being a role model for teaching. It is likely, then, that learning how to teach primary science as a source of self-efficacy fits Bandura’s (1997) idea of vicarious experience.

Bandura (1997) also argued that a person’s physiological and affective state could influence their self-efficacy. For example, a heightened state of nervousness when undertaking an activity might decrease self-efficacy. No interview response to Question 15 of the interview described a physiological or affective state as being a source of self-efficacy.
Bandura (1997) described verbal persuasion as another, though relatively weak source of self-efficacy. For trainee teachers, verbal persuasion could refer to credible and realistic appraisals from observations of their performances in teaching science that could suggest a capability for the task. This feedback would potentially be more accepted by a student if peers of similar ability or an experienced teacher had provided the verbal opinions. A person’s beliefs could be strengthened if the feedback were positive. Verbal persuasion was not mentioned in interview responses as a cause of enhanced self-efficacy.

Teacher qualities of enthusiasm and passion as a source of self-efficacy for teaching science were not directly included in Bandura’s sources of self-efficacy. However, they could be considered part of vicarious experience. Students in the study watching the teacher act with passion and enthusiasm could see themselves bringing passion and enthusiasm into their teaching of science.

Were sources of situational interest also sources of self-efficacy in the present study?

As explained above, the factors affecting self-efficacy were learning how to teach primary science, understanding the background knowledge, and teacher qualities of enthusiasm and passion for teaching science. In the questionnaires, the main sources of situational interest were specific teaching techniques, relevance to teaching primary science, learning, teacher qualities, novelty, physical activity, and social interaction. The last three sources were not identified in any interview responses in relation to self-efficacy. Hence, these three are excluded in the comparisons of sources of situational interest with the sources of self-efficacy in the
Teaching techniques

Students’ responses in questionnaires explicitly referred to specific teaching techniques of toy use, hands-on activities, experiments, stories (anecdotes), science magic, analogies, demonstrations, and fun facts as arousing situational interest. The same teaching techniques were noted as generators of situational interest in the interviews. These teaching techniques were further described by students in interviews to explain reasons for a cause of self-efficacy enhancement and were thus coded in the category of learning how to teach primary science.

Therefore, the use of specific teaching techniques such as toys, hands-on activities, experiments, stories (anecdotes), science magic, analogies, demonstrations, and fun facts not only generated situational interest, but also they enhanced self-efficacy, but for a slightly different reason. Through the teacher’s modelling of these techniques the students believed they had learnt how to teach primary science.

Relevance to teaching primary science

Relevance for preservice primary teachers’ future profession was a source of situational interest. One of the sources of self-efficacy was learning how to teach primary science. These two are similar because they both are derived from the use of activities that would be appropriate for primary school. However, they are also subtly different because situational interest was enhanced by the relevance of these activities whereas self-efficacy was enhanced by developing knowledge about these activities. This does suggest, however, that the use of teaching techniques that are
appropriate for primary school could have the effect of arousing situational interest and a parallel, but distinct, arousal of self-efficacy.

Learning

Participants’ comments about learning as a source of situational interest focused on the motivation and positive affect associated with understanding something for the first time. Similarly, self-efficacy was enhanced by learning how to teach primary science and understanding the background knowledge. Learning was a source of situational interest, and, more specifically, learning how to teach science and learning science content were also sources of self-efficacy.

Teacher qualities

The descriptors for coding teacher qualities as a source of situational interest also connected to increased self-efficacy. They both referred to the passion and enthusiasm for science exhibited by the teacher. For situational interest, participants referred to the teacher’s enthusiasm and passion for teaching science that made them want to learn the content. For self-efficacy, participants explained that the teacher’s qualities of passion and enthusiasm in teaching made them confident that they could demonstrate similar enthusiasm and passion as teachers.

7.4.3 Summary of the findings for Research Question 3

In summary, for Research Question 3 of this study, triangulated evidence from multiple data sources that assessed self-efficacy for teaching science indicate that self-efficacy improved. This increase in self-efficacy remained stable over the ten months after the science content unit finished. Data analysis pointed to the following
sources of self-efficacy:

1. learning how to teach primary science
2. understanding the background knowledge
3. teacher qualities of passion and enthusiasm for teaching science

Some of the sources of situational interest also assisted in the development of self-efficacy. The extensive use of teaching techniques such as toys, hands-on activities, experiments, stories (anecdotes), science magic, analogies, demonstrations, and fun facts generated situational interest but also had the effect of modelling science teaching, so the students believed they had learnt how to teach primary science. The learning that occurred in the science unit had the effect of arousing situational interest and also self-efficacy. Feeling successful at learning is a strong motivator to continue learning. In this case, the learning was about the science content as well as the teaching of science. Similarly, teacher enthusiasm can be a source of situational interest as well as a source of self-efficacy in the sense that I could model her behaviour and become an enthusiastic teacher of science too. In this way, some of the sources of situational interest can also enhance self-efficacy.

As discussed in Chapter 5, the statistical analyses showed strong positive correlations between individual interest in science and self-efficacy to teach science at the three times of measurement. The argument has been mounted that the same teaching behaviours stimulated interest in science as well as enhancing self-efficacy to teach science. Does that mean that the correlation between self-efficacy to teach science and individual interest in science is a spurious one? That is, the two “real” relationships are between interest in science and teaching behaviours and between
self-efficacy to teach science and the same teaching behaviours. On the other hand, a
two-way relationship between interest in science and self-efficacy to teach science
makes sense: interest in science enhances self-efficacy to teach science and
heightened self-efficacy to teach science enhances interest in science.

On the other hand, a two-way relationship between interest in science and self-
efficacy to teach science makes sense: interest in science enhances self-efficacy to
teach science and heightened self-efficacy to teach science enhances interest in
science. The link between interest and relevance has a bearing here too. Hulleman
and Harackiewicz (2009) demonstrated that students who saw the personal relevance
of science they were learning found science more interesting. In the current study,
self-efficacy was enhanced because participants felt confident they could do
something highly relevant to them, that is, understand science concepts and how to
teach them.

The finding that teacher enthusiasm can be a source of self-efficacy is a
potentially important one because this has not been identified previously in the
literature. The participants’ responses about teacher qualities as a cause of self-
efficacy reported that the teacher’s enthusiasm, passion, and obvious enjoyment of
science assisted in developing their confidence to teach science in a similarly
passionate manner. Teacher enthusiasm and passion were described in the interviews
as being contagious. Perhaps, “catching” the teacher’s enthusiasm inspired the
participants. This infectious nature of teacher qualities has been described as
“emotional contagion” (Hatfield, Cacioppo, & Rapson, 1993).
7.5 Limitations

There are limitations that should be considered when interpreting the results of this study, and these are explained in the following section.

Are the results generalisable?

The findings of this study can be generalised to similar groups of people and settings beyond this research context (McMillan & Schumacher, 2010).

First, the results would be most applicable to students similar to those who participated in the study. These participants were primary teacher education students in their first year of training at a university in Australia. The study results, then, could only confidently apply to the population of primary teacher education students at this university and similar groups of teacher education students of mainly Western cultural background at the university level. It cannot be assumed that the study’s results could be applicable to students of other cultural backgrounds or university students outside of primary teacher education.

Second, since the participants were mainly aged between 18-22 years, the results may not apply to students of other ages. The teaching techniques used in the present study may not arouse situational interest in younger people or older people. Similarly, the sources of self-efficacy identified in this study may be different from the needs and educational experiences of younger or older students. Third, because the study was conducted in a science content unit for primary teacher education, it is not certain that the findings could be generalised to other discipline areas of the university.
**Self-reporting**

Self-reporting is a limitation of the study because a self-report cannot be substantiated independently. For example, the researcher did not see participants talking to others about science topics, reading articles about science, or watching science shows on television. Given the time limitations of conducting a research higher degree, self-reports are an alternative to observing the behaviour of a large number of participants over a long period of time. Apart from the quantitative survey assessing participants’ individual interest in science, there were a number of self-report data collections. Participants could provide self-generated responses about their personal experiences, feelings, and opinions, often with an extended clarification of what they meant (in the interviews). Self-reports about arousal of situational interest, increased interest in science, and potential sources of self-efficacy for teaching science were presumed to be accurate, in part because of the triangulation of data from different sources that was used in this study.

As noted earlier, participants who agreed to an interview may be those who had a positive experience during the science course. Participants with a less positive experience during the science course would be less likely to volunteer for an interview.

**Times of testing**

Finally, the study would be strengthened with additional times of measurement. Was participants’ reported individual interest in science sustained over a significant period of time? The current study had three times of measurement
for quantitative data: a pretest, an immediate posttest, and a delayed posttest ten months after the science unit had been completed. There was a drop in reported interest in science from the immediate posttest to the delayed posttest, though interest at the delayed posttest remained significantly higher than it was at the pretest. If data were gathered at a fourth time point, for example, ten months after the delayed posttest, would interest continue to fall? Given the time constraints of a research higher degree, it was not possible to gather data at a fourth of fifth time point.
Chapter 8

Conclusions

8.1 Introduction

Three research questions were addressed in this study:

**Research Question 1:** Can situational interest be aroused during a science content unit for primary teacher education students, and if this does occur, how does this occur?

**Research Question 2:** Can strategies designed to generate situational interest enhance preservice primary teachers’ long-term individual interest in science?

**Research Question 3:** Can self-efficacy for teaching science be enhanced by use of the strategies designed to arouse situational interest?

Conclusions for Research Question 1 about possible situational interest arousal during the science content unit are found in Section 8.2. These conclusions are the result of participant responses to questionnaires about what interested them during the science content unit, a survey of their personal rating of the level of interest generated by the teaching techniques, and from individual interview responses.

Conclusions for Research Question 2 with regard to possible individual interest enhancement in science are presented in Section 8.3. These conclusions are gained from survey data about individual interest in specific science topics and in science related activities, questionnaire response data from possible changes in their interest in science, as well as responses from individual interviews.

Conclusions to Research Question 3 of the study from analyses of survey data
and participant responses in individual interviews about participants’ personal beliefs of self-efficacy to teach science are found in Section 8.4.

Each of the sections also contains conclusions in relation to other significant findings of the study. Implications of the study for primary teacher education and for future research are explained in Section 8.5.

8.2 Conclusions for Research Question 1: Can situational interest be successfully aroused during a science content unit for primary teacher education students, and if so, how does this occur?

Conclusion 1: Situational interest can be aroused during a science content unit for primary teacher education students. Evidence for this conclusion was collected by questionnaire, interviews, and survey.

Conclusion 2: The main sources of situational interest were specific teaching techniques (mainly hands-on activities, science magic, demonstrations, toys, anecdotes, analogies, and fun facts during the science lectures and/or tutorials), relevance to teaching primary science and to life, learning, teacher qualities of enthusiasm and passion, novelty, physical activity, and social interaction. These were identified from questionnaires, interviews, and survey. As noted earlier, there was a degree of overlap among these sources so it is misleading to treat them as independent sources.

Conclusion 3: Teacher enthusiasm is a source of situational interest. This finding has not previously been identified in the situational interest literature. This finding was supported by evidence from questionnaires and interviews. It was an
important finding because it adds a new strategy that teachers can use to generate situational interest in students.

**Conclusion 4:** Science magic is a specific teaching technique that was designed to explain a science concept in a mysterious way to create a sense of wonder, surprise, and unexpectedness. Science magic has not been previously identified in situational interest literature which makes it a new source of situational interest. Evidence for this finding was collected by questionnaires, survey, and interviews.

**Conclusion 5:** The use of toys was a teaching strategy that was found to stimulate situational interest in students. Questionnaires, surveys, and interviews provided the evidence for this finding that has not been in the situational interest literature. The finding adds a new strategy that teachers can use to arouse situational interest in students.

**8.3 Conclusions for Research Question 2: Can strategies designed to generate situational interest enhance preservice primary teachers’ long-term individual interest in science?**

**Conclusion 1:** Individual interest in science can be substantially enhanced during a science content unit. Evidence for this conclusion was collected by questionnaire, surveys, and interviews.

**Conclusion 2:** The sources of positive change in a long-term individual interest in science were *specific teaching techniques* (e.g., hands-on activities, science magic, demonstrations, toys, anecdotes, analogies, and fun facts), *relevance to teaching*
primary science, teacher qualities of enthusiasm and passion, learning, and novelty. Evidence was collected by questionnaires, interviews and surveys to support this conclusion.

**Conclusion 3**: The sources of an increase in individual interest in science, except for physical activity and social interaction, were the same as sources of situational interest, that is, specific teaching techniques, relevance to teaching primary science, successful learning, teacher qualities of enthusiasm and passion and novelty. This conclusion was supported by evidence from interviews and questionnaires.

**Conclusion 4**: Teacher enthusiasm is a source of individual interest. Supported by evidence from questionnaire and interviews, this was a finding that has not previously been reported in individual interest literature. The finding adds the strategy of teacher enthusiasm and passion to generate individual interest in science amongst students.

**Conclusion 5**: Increased individual interest in science not only included interest in topics that had been taught, but also interest in topics that had not been taught.

**Conclusion 6**: Increased individual interest in science also was measured by reports of engagement in science-related activities. After the science content unit, students reported being much more involved in talking about science, reading about science, and watching science shows than they had previously. There was a reduction
in reported engagement in science-related activities at the third time of measurement, ten months after the science unit had finished. However, reported engagement remained significantly higher than it had been at the beginning of the science unit.

8.4 Conclusion for Research Question 3: Can self-efficacy for teaching science be enhanced by use of the strategies designed to arouse situational interest?

**Conclusion 1**: Self-efficacy for teaching science can be enhanced in a science content unit. Evidence for this conclusion was collected by surveys and interviews. It should be noted that this unit was designed specifically for preservice primary education teachers and contained a wide variety of innovative teaching techniques.

**Conclusion 2**: The sources of increased self-efficacy to teach science were *learning how to teach primary science, understanding the background knowledge,* and *teacher qualities* of enthusiasm and passion.

**Conclusion 3**: Some sources of situational interest also enhanced self-efficacy. The use of teaching techniques such as toys, hands-on activities, experiments, stories (anecdotes), science magic, analogies, demonstrations, and fun facts generated situational interest and also developed self-efficacy. Success with learning science content and how to teach science developed situational interest and also self-efficacy. Evidence for this conclusion was collected by interviews and questionnaires.

**Conclusion 4**: Teacher qualities of enthusiasm and passion were determined as a source of self-efficacy to teach science and a source of situational interest. This was an important finding because this relationship has not previously been identified in
the self-efficacy literature. Evidence for this conclusion was collected by interviews.

8.5 Implications

The findings of this study have implications for primary teacher education and for future research.

Primary teacher education

Science is a priority learning area of the Australian primary school curriculum. However, there are many problems in this area: many teachers are reluctant to engage with science in the classroom because they dislike science and lack confidence in their ability to teach science (Dekkers & De Laeter, 2001; De Laat & Watters, 1995; Palmer, 2006b; Skamp & Mueller, 2001; Tytler et al., 2008; Watters & Ginns, 2000). Effective professional preparation of preservice teachers is important to improve the quality of science teaching in Australian primary classrooms (Dekkers & De Laeter, 2001; Goodrum et al., 2001). The findings of this study show that changes can be made in the preparation of primary teachers. They can learn to enjoy science and to develop a high self-efficacy to teach science. The use of teaching strategies in this study that were designed to generate situational interest also resulted in many participants developing a long-term individual interest in science. Additionally, as a result of the use of the same teaching strategies, self-efficacy to teach science was enhanced.

Research has also indicated that many preservice primary teachers are concerned that they will lack specialised language and specialised equipment to teach scientific concepts in primary classrooms (Rennie et al., 2001). This study
demonstrated that these concerns can be reduced if the university teacher models relevant teaching techniques using simple, everyday language and simple everyday objects. Each teaching strategy used in the current study covered a scientific concept using inexpensive and easily accessed resources from home, supermarket, or school. This study’s range of teaching strategies provided preservice primary teachers with a repertoire of instructional ideas and easily understood and expressed science content for their future classrooms.

**Future research**

This study has produced clear and useful findings for the preparation of preservice primary teachers to teach science. Further research is needed to confirm a causal link between situational interest and long-term individual interest in science. Using similar teaching techniques, this study could be replicated in more culturally diverse populations of preservice teachers. The outcome could be verification of the sources of situational interest, reasons for increases in individual interest in science. In addition, possible causal links among sources of situational interest in science, sources of individual interest in science, and self-efficacy to teach science could be explored more thoroughly.

Two teaching techniques, science magic and the use of toys, as well as teacher enthusiasm, were found to generate situational interest but they have not been investigated in previous situational interest literature. Further research could be undertaken to assess the potential of these teaching techniques as sources of situational interest for different types of students. Finally, research has shown that strategies designed to generate situation interest are desirable because they focus
students’ attention, thereby improving students’ learning (Hidi & Harackiewicz,
2000; Mitchell, 1993; Renninger et al., 2002; Schiefele et al., 1992; Wade, 2001;
Wade et al., 1993). The teaching strategies used in the current study may enhance
students’ learning in a range of science classrooms. Future studies could investigate
how specific teaching strategies that were designed to increase situational interest
enhance students’ comprehension of the science concepts.
References


dissertation). Florida State University, Florida.


Palmer, D. (2004b). Situational interest and the attitudes towards science of primary


Quarterly, 28, 3-24.


When this research was started, my student name was Jeanette Rothapfel. Hence, some appendices refer to Jeanette Rothapfel. Since 2012, my name has changed to Jeanette Dixon.
Appendix A

Associate Professor David Palmer  
School of Education  
Faculty of Education and Arts  
The University of Newcastle  
University Drive, Callaghan, NSW 2308  
Telephone: 49215715 Fax: 49217887  
David.Palmer@newcastle.edu.au

Information Statement for the Research Project:  
Enhancing preservice primary teachers’ interest in science and self-efficacy for teaching science  
Document Version 2; dated 25/11/09

The Research Team

Associate Professor David Palmer, Dr Jennifer Archer and Jeanette Rothapfel  
The research is a part of Jeanette Rothapfel’s PhD studies at the University of Newcastle, supervised by Associate Professor David Palmer and Dr Jennifer Archer from the School of Education.

Why is the research being done?

The study will investigate pre-service teachers’ interest in science and confidence to teach science. Hence, the aim will be to find out whether participation in the Foundations of Science and Technology course enhances student interest in science and confidence to teach science.

Who can participate in the research?

We are seeking the participation of students studying in the SCIM2030 course or Foundations of Science and Technology course in the science tutorials only conducted by Jeanette Rothapfel.

What choice do you have?

Participation in this research is entirely your choice. Whether or not you decide to participate, your decision will not disadvantage you. If you do decide to participate, you may withdraw from the project at any time without giving a reason and have the option of withdrawing any data which identifies you. You can also decide to participate at any time.

What would you be asked to do?

If you agree to participate, you will be asked to contribute to data collection by the following:

1. Complete a survey after the first tutorial session.
2. Complete a very short, written response to one question every third tutorial to indicate the level of interest that was generated by activities used by the researcher.
3. At the completion of the course, students will complete the survey noted in Step 1 and complete Survey 2 comprised of two questions only.
4. Students who indicate their willingness to be interviewed will undertake an interview to gauge the effectiveness of the teaching strategies to enhance personal
interest. Also, students will be asked about their experiences of science before this course, particularly their experiences of science in schools.

5. Six months later, students will complete the survey noted in Step 1.

How much time will it take?

1. Survey No 1 will take about 10 minutes to complete at the beginning of the project after the first tutorial.
2. Questionnaire 1 (one question) will take only 5 minutes to complete after every third tutorial.
3. Survey No 1 will be repeated at the end of the course, and with Questionnaire 2 (two questions) will take about 15 minutes to complete.
4. An interview with volunteer students only at the end of the course will take about 20 minutes.
5. Survey 1 will be repeated again about six months later, taking about 10 minutes.

What are the risks and benefits of participating?

There are no risks to student participation. The benefits will be that students in the course will be exposed to effective teaching strategies and relevant resources that can be used in their own classrooms. It is anticipated that enhanced personal interest in science will heighten self-efficacy to teach science resulting in more effective teaching of science in primary classrooms.

How will the information collected be used?

Individual participants will not be identified in any reports arising from the project. Student participants will also be provided with a summary of the findings in lay language on a website. Students will be able to review any audio recording and transcript to edit or erase the comments of an interview. The results, with no identification of students, will be used in the thesis to be submitted for Jeanette Rothapfel’s PhD, and also in conference papers and articles in educational journals.

What do you need to do to participate?

Please read this Information Statement and be sure you understand its contents before you consent to participate. If there is anything you do not understand, or you have questions, contact the researcher. If you would like to participate in the surveys and/or interview, please complete the attached Consent Form and return it by placing it in the box at the door of the tutorial classroom. You will be contacted towards the end of the course to arrange a time convenient to you for the interview.

Further information

If you would like further information about the project, please contact Associate Professor David Palmer or Jeanette Rothapfel.

Thank you for considering this invitation.

Associate Professor David Palmer
Jeanette Rothapfel

Complaints about this research

This project has been approved by the University’s Human Research Ethics Committee, Approval No. H-2009-0354.

Should you have concerns about your rights as a participant in this research, or 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 for the Research Project:

Enhancing preservice primary teachers’ interest in science and self-efficacy for teaching science

The Research Team
Associate Professor David Palmer, Dr Jennifer Archer and Jeanette Rothapfel
Document Version 2; dated 25/11/09

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 project at any time and do not have to give any reason for withdrawing.

I consent to participating in an interview with audio recording of the interview.

(Please circle your answer.)  Yes  /  No

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

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

Print
Name:____________________________________________________________

Student email address (for arranging an interview only, not for identification)
____________________________________________________________________

Signature: __________________________________ Date: ____________________
**Survey 1: Interest in Science Topics**

**How interested are you in learning about the following?**

*The Research Team*

Associate Professor David Palmer, Dr Jennifer Archer and Jeanette Rothapfel
Telephone: 49215715 Fax: 49217887  David.Palmer@newcastle.edu.au
University of Newcastle

Name: ______________________
(It is not necessary to write your name on this survey, so please write the first and second names of your mother.)

**Gender: M / F**

**Age:** 18-22  23-27  28+

**Are you a ‘direct from school’ student?**  Yes / No

**Are you a ‘mature age entry’ student?**  Yes / No

Please indicate your level of interest in learning about the following topics of science by placing a ✓ under the appropriate description on the right.

<table>
<thead>
<tr>
<th>Science Topic</th>
<th>Very Uninterested</th>
<th>Not Interested</th>
<th>Neutral</th>
<th>Interested</th>
<th>Very Interested</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Universe</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Chemical reactions</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Volcanoes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Wildlife</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Human body</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Weather</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Earthquakes</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Marine science</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Space exploration</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Diseases</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Fossils</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. Radioactivity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Inheritance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. Chemicals</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Rocks</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. Flight</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. Energy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. Forensic Science</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. Dinosaurs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Invertebrate animals e.g., insects</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix D

Survey 2: Personal Interest in Science

Please indicate how each activity below reflects your personal interest and involvement in science by placing a ✓ under the appropriate description on the right.

<table>
<thead>
<tr>
<th>Current personal interest in a science activity</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Often</th>
<th>Very often</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I take an interest in science news.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. I read articles about scientific discoveries.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. I like to understand scientific ideas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. I talk about science with friends.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. I discuss things I learn about science with my family.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. I watch science shows on television.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. I listen to shows about science on the radio.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. I look up information about science on the web.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. I would like to study more science in the future.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. I like to find out about science related issues.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. I spend my spare time doing science related activities.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. I like to think about science problems.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. I am interested in the work that scientists do.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. I am interested in the way that scientists make discoveries.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. I would be interested in learning more science than my degree program requires.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Appendix E

**Preservice Primary Science Teaching Efficacy Belief Instrument**

Please indicate the degree to which you agree or disagree with each statement below by placing a `✓` under the appropriate letters to the right of each statement.  
SA = Strongly Agree, A = Agree, UN = Uncertain, D = Disagree, SD = Strongly Disagree

<table>
<thead>
<tr>
<th></th>
<th>SA</th>
<th>A</th>
<th>UN</th>
<th>D</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. When a student does better than usual in science, it is often because the teacher exerted a little extra effort.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. I will continually find better ways to teach science.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Even if I try very hard, I will not teach science as well as I will most subjects.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. When the science grades of students improve, it is most often due to their teacher having found a more effective teaching approach.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. I know the steps necessary to teach science concepts effectively.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. I will not be very effective in monitoring science experiments.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. If students are underachieving in science, it is most likely due to ineffective science teaching.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. I will generally teach science ineffectively.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. The inadequacy of a student's science background can be overcome by good teaching.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. The low science achievement of some students cannot generally be blamed on their teachers.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. When a low achieving child progresses in science, it is usually due to extra attention given by the teacher.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12. I understand science concepts well enough to be effective in teaching science.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13. Increased effort in science teaching produces little change in some students' science achievement.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14. The teacher is generally responsible for the achievement of students in science.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15. Students' achievement in science is directly related to their teacher's effectiveness in science teaching.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16. If parents comment that their child is showing more interest in science at school, it is probably due to the performance of the child's teacher.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17. I will find it difficult to explain to students why science experiments work.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18. I will typically be able to answer students' science questions.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19. I wonder if I will have the necessary skills to teach science.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20. Given a choice, I will not invite the principal to evaluate my science teaching.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>21. When a student has difficulty understanding a science concept, I will usually be at a loss as to how to help the student understand.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22. When teaching science, I will usually welcome student questions.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>23. I do not know what to do to turn students on to science.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Appendix F

Questionnaire 1

What interested you in this tutorial?

Name used in surveys and questionnaires: ________________________

Gender: M / F
Age:  18-22   23-27   28+
Are you a ‘direct from school’ student? Yes / No
Are you a ‘mature age entry’ student? Yes / No

Write down anything that interested you during the tutorial. Please explain as fully as you can.

Please list any other things that interested you in this tutorial

1.
2.
3.
4.
5.

________________________________________

Research Project:
Enhancing pre-service primary teachers’ interest in science and self-efficacy for teaching science

The Research Team
Associate Professor David Palmer, Dr Jennifer Archer and Jeanette Rothapfel
Telephone: 49215715 Fax: 49217887  David.Palmer@newcastle.edu.au
Appendix G

Questionnaire 2
Did you change your interest in science?

The Research Team
Associate Professor David Palmer, Dr Jennifer Archer and Jeanette Rothapfel
Telephone: 49215715 Fax: 49217887  David.Palmer@newcastle.edu.au
University of Newcastle

Name used in surveys and questionnaires: ____________________________

Gender:  M / F
Age:  18-22  23-27  28+
Are you a ‘direct from school’ student?  Yes / No
Are you a ‘mature age entry’ student?  Yes / No

1. Has your interest in science changed while doing this science unit?

   Please circle A or B or C below.

   A.  It has increased my interest in science.

   B.  It has not changed my interest in science.

   C.  It has decreased my interest in science.

2. What caused a change, or not, in your interest in science? Please explain as fully as possible.
Survey 4: Level of Interest Generated by Teaching Strategies During Tutorials and Lectures

<table>
<thead>
<tr>
<th>Some strategies used during tutorials and lectures</th>
<th>Level of interest you experienced as these were being used (5 highest)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Science magic</strong> e.g., the disappearing water in a cup (nappy chemical trick), magic coin trick (reappearing coin in water), magic coloured milk, willing a coin to move on top of a glass bottle, magically moving pepper and ‘bread clip boats’ on water</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td><strong>Demonstrations</strong> e.g., extraction of strawberry DNA, straw through a potato, removing a coin from the bottom of a pile of coins (inertia magic), blowing up a balloon from yeast fermentation, colour blindness test, optical illusions</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td><strong>Hands-on activities</strong> e.g., launching Alka-Seltzer rockets, weightlessness of water in a falling cup, burning leaves with magnifying glasses, changing colour of nail polish in UV radiation, rattle snake magnets, separating colours in textsas, tasting PTC paper for bitterness, match stick pulse rate monitor, natural selection of Scimmer birds with different beaks</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td><strong>Fun facts (or science trivia)</strong> e.g., Tycho Brahe’s artificial nose from a duel accident, Galileo’s exoneration in 1992 for saying that the Earth was not at the centre of the universe after 360 years, possible life on Mars, William the Conqueror and the 1066 comet, snotittes as extremophiles, how to go to the toilet in space, space accidents, recycling of urine in space, astronaut testing falling objects on the Moon</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td><strong>Use of toys</strong> that demonstrate scientific principles or useful strategies for the classroom e.g., rainbow glasses, fun fly stick, sound tubes, spy glasses, UFO ball, bounce and no-bounce balls, Airzooka, Newton’s cradle, solar grasshopper, toy dinosaurs, magnetic gears, digestive system apron, dinosaur hand puppets, the incredible expanding bunny, Disney flicker books</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td><strong>Useful verbal and modelling analogies</strong> i.e., comparing a science concept to something in everyday life to increase understanding of the concept. e.g., modelling the Solar System with fruit and vegetables, modelling the distance of the Moon from Earth, using buses filled with hundreds and thousands as an analogy for stars in our galaxy, the cell membrane is a border control like ‘bouncers’ outside a nightclub only allowing only some customers to enter, squishy cell and eye models</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td><strong>Anecdotes</strong> e.g., my personal and other stories to assist students connect to and learn from everyday life. e.g., home-made ginger story about fermentation, student colour-blindness inheritance discovery, problem associated with the space toilet breakdown with astronaut colleague</td>
<td>1 2 3 4 5</td>
</tr>
</tbody>
</table>
Appendix I

Examples of teaching techniques, resources and worksheets used in this study

**Hands-on science activities**
Some examples of these strategies to stimulate situational interest are listed below.

- Weightlessness of water in a falling cup to demonstrate that astronauts are weightless due to free-falling in space, not due to the absence of gravity.
- Removing a coin from the bottom of a pile of coins without manually moving the upper coins to demonstrate inertia.
- Launching Alka-Seltzer rockets to simulate Newton’s Third Law of Motion for rocket launching.
- Separating colours in the chromatography process.
- Tasting PTC paper to determine if the students had inherited the dominant gene for tasting the bitter chemical phenylthiocarbamide.
- Making a match stick pulse rate monitor to use in heart/pulse/exercise experiments.

**Toys that demonstrate scientific principles**
Some examples of toys used in the tutorials to demonstrate scientific principles with respect to the topic of ‘Energy’ can be seen in the table below.

*Some Toys used in Hands-On Activities*

<table>
<thead>
<tr>
<th>Toys</th>
<th>Science concept demonstrated</th>
</tr>
</thead>
<tbody>
<tr>
<td>rainbow glasses</td>
<td>light dispersion</td>
</tr>
<tr>
<td>3D frog mirage</td>
<td>light reflection</td>
</tr>
<tr>
<td>spy glasses</td>
<td>light reflection</td>
</tr>
<tr>
<td>periscope</td>
<td>light reflection</td>
</tr>
<tr>
<td>potato clock</td>
<td>simple battery</td>
</tr>
<tr>
<td>sound tubes</td>
<td>sound - air vibrations</td>
</tr>
<tr>
<td>thunder drums</td>
<td>sound vibrations</td>
</tr>
<tr>
<td>slinky with foam cup</td>
<td>sound production and amplification</td>
</tr>
<tr>
<td>solar grasshopper, car, cockroach</td>
<td>energy changes</td>
</tr>
<tr>
<td>rattle snake magnets</td>
<td>magnetism</td>
</tr>
<tr>
<td>UFO balls</td>
<td>energy changes</td>
</tr>
<tr>
<td>jumping frogs</td>
<td>energy changes</td>
</tr>
<tr>
<td>jack-in-the-box</td>
<td>energy changes</td>
</tr>
</tbody>
</table>
Some other toys that were also useful for science activities were as follows:

- A wand, a miniature Van der Graaf generator, called a Fun Fly Stick™ demonstrated repulsion from static electricity by the movement of light-weight, metallic shapes to move away from the wand after they were originally placed on the wand before charging.
- bounce and no-bounce balls, Airzooka, Newton’s cradle, solar grasshopper, toy dinosaurs, magnetic gears, digestive system apron, dinosaur hand puppets, the incredible expanding bunny, Disney flicker books

Some toys that were also useful for science magic activities for other science concepts were as follows:

- A wand, a miniature Van der Graaf generator, called a Fun Fly Stick™ demonstrated repulsion from static electricity by the movement of light-weight, metallic shapes to move away from the wand after they were originally placed on the wand before charging.
- The toy, often called ‘Newton’s Nightmare’™, looked like a metallic object within the tube was defying gravity but was actually demonstrating Lenz’s law. When a nonmagnetic weight made of brass was first dropped into an empty aluminium tube, it rapidly fell out the bottom, as expected, to obey gravity. Then, when another weight (secretly a strong Neodymium magnet that looked like the other brass weight) was dropped into the tube, it moved down in slow motion, as if by magic. This weight seemed to defy gravity but relied on repulsion of magnetic fields, one from the strong magnet and the other from the current of electricity produced in the metal tube as the strong magnet moved down the tube.

**Science magic**

Some examples of science magic utilised in the tutorials were:

- The disappearing water in a cup (sodium polyacrylate in a disposable nappy or diaper trick) to demonstrate the use of the maximum absorbency garment that astronauts wear during launch, reentry and spacewalks. This activity can be found later in this Appendix.
- A coin, out of sight from the viewer, was made to reappear in a bowl after the addition of water to demonstrate refraction of light.
- ‘Willing’ a coin sitting on top of an empty bottle to move to demonstrate the convection of heated air caused by the warm hands wrapped around the bottle. This activity can be found later in this Appendix.
- Magic milk – creating a variety of swirling food colours on the surface of milk from the detergent reduction of surface tension on the surface of milk and for demonstrating colour combinations. This activity can be found later in this
Appendix.

- Moving ground pepper and bread clips boats on the surface of water for demonstrating that detergent reduces surface tension. This activity can be found later in this Appendix.

**Demonstrations**

Some examples of entertaining demonstrations utilised in the tutorials that could easily be presented as hands-on activities are listed below.

- Extraction of DNA from strawberries to demonstrate the simple process of being able to extract and observe this ‘abstract’ substance. This activity can be found later in this Appendix.
- Making a flexible drinking straw easily pass through a raw potato to simulate the power of a small, speeding meteoroid in space striking a spacecraft. This activity can be found later in this Appendix.
- Blowing up a balloon from yeast fermentation to demonstrate that yeast is a living organism that, once in a warm sugar solution, releases carbon dioxide during the respiration.
- Colour blindness test for the students to assess sex-linked inheritance.
- Natural selection game of birds with different beaks. Pegs, spoons, chop sticks were used as different beaks to investigate which bird beaks were most successful in ‘catching’ beans, the food, that eventually may influence natural selection.
- Optical illusions to demonstrate the inefficiency of the brain to interpret information collected by the eyes.

**Fun science facts**

Some examples of fun facts utilised in the tutorials or lectures are listed below.

- How the toilet operates in space and how astronauts undertake bathing, eating, sleeping and cleaning of hair and teeth.
- Recycling of urine in space aboard the International Space Station for water consumption.
- Apollo astronaut tested falling objects on the Moon to confirm that Aristotle’s idea about falling objects was incorrect.
- Galileo’s exoneration in 1992 after 360 years for saying that the Earth was not at the centre of the universe.
- Snottites are colonies of bacteria that are examples of extremophiles that survive and thrive in the acidic conditions. Encased in protective mucous similar to mucous running from the nose, the snottites hang from the walls and ceilings of toxic sulfur caves.
- The reason for a genus of fossil ammonite being named Hildocerus after Saint
Hilda. The legend tells of the nun and abbess Hilda at Whitby turning a plague of snakes into stones, so explaining the presence of the ammonite fossils in the rocks on the shore at Whitby.

**Analogies**
Some examples of useful analogies utilised in the tutorials or lectures are listed below.

- Modelling the Solar System with fruit and vegetables. This activity can be found later in this Appendix.
- Modelling the distance of the Moon from Earth with scaled bodies and rope. The activity for this analogy can be found later in this Appendix.
- Using an animation of 15 buses filled with hundreds and thousands, or cake sprinkles, as an analogy for stars in a galaxy of 200 billion stars.
- The semi-permeable, cell membrane is a border control like ‘bouncers’ outside a nightclub only allowing only some customers to enter.
- Locating stomata on the underside of a leaf placed in warm water was like the air bubbles forming over pores in the skin when resting in a warm bath.

**Anecdotes**
Some examples of suitable anecdotes utilised are listed below.

- This researchers’ experiences at NASA with respect to research undertaken in the Astromaterials Research and Exploration Science department at the Johnson Space Center in Houston (home of the Moon rock samples), space shuttle launches as guest of an astronaut, and professional experiences with astronauts that had become colleagues.
- Problem associated with the space shuttle toilet breakdown on a recent mission involving an astronaut colleague that the researcher had been working with.
- Home-made ginger beer story about fermentation producing alcohol, a situation unfortunately not realised by the researcher’s parents when she was a child. This also acted as a warning to students, most of whom were also not aware of the production of alcohol when making ginger beer.
- Researcher’s personal experiences in Egypt with respect to relevant information about the rocks and fossils from Egypt used in the tutorials.
Some worksheets used in tutorials
Examples of situational interest generating strategies that generated high interest for students

Examples of student worksheets written and provided for students to complement the situational interest generating strategies used in the treatment. These activities were relevant ideas and resources for the preservice elementary teachers to use directly in their future classrooms.

1. Hands-on activities
One example of a hands-on activity that interested the students was the launching of an Alka Seltzer\textsuperscript{TM} rocket for the topic of space travel for Newton’s Third Law of Motion. The work sheet for this hands-on activity undertaken by the students is presented below.

**How does a rocket launch into space?**

Sir Isaac Newton defined a very important law that states that ‘every action has an equal and opposite reaction’. This law is known as Newton’s Third Law of Motion. In rocketry it means that if an object provides a downwards push, then there should be an equal and opposite force pushing the object upwards.

**Aim:** To demonstrate how a rocket launches by making an Alka Seltzer\textsuperscript{TM} rocket.

**Equipment needed**
- One empty film canister that has a lid that fits into the canister. Do not use one that has a lid that slips over the top of the container. These containers are freely obtained from any film processing shop.
- One quarter of an Alka-Seltzer* tablet
- A small quantity of water

**What to do**
- Place the piece of Alka-Seltzer* tablet inside the film canister.
- Add about 1 cm of water and quickly seal the canister with the lid
• Place the canister upside down on the ground. This means that the lid should be touching the ground.
• Stand clear immediately so that the canister does not fly up into your face. It will take a short time for ‘launch’ so do not become impatient. Never go near the rocket until you are very sure that it is not going to have ‘lift-off’.
• Weight is a factor seriously considered for successful launches. Determine how the height is affected when the rocket’s weight is increased with a small ‘payload’.
  a) What is the fuel for this launch?
  
  b) Did the rocket reach higher altitudes, the more water you placed in it? Yes/No
  c) What two words from Newton’s 3rd Law of Motion describe what is happening? ______________________________________________


2. Analogy activities
   Let’s eat our Solar System model

You can represent the sizes of planets using food that you may have at home. Before you use the suggested food items in the table to build your Solar System, match the planet or dwarf planet name in the table with the appropriate item of food that best represents the size of the planet in comparison to the others.

<table>
<thead>
<tr>
<th>Planet/Dwarf Planet</th>
<th>Food item</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>Large cabbage</td>
</tr>
<tr>
<td>Venus</td>
<td>Small grape</td>
</tr>
<tr>
<td>Earth</td>
<td>Large orange</td>
</tr>
<tr>
<td>Mars</td>
<td>Small cabbage or lettuce</td>
</tr>
<tr>
<td>Jupiter</td>
<td>Small plum</td>
</tr>
<tr>
<td>Saturn</td>
<td>Large Grape</td>
</tr>
<tr>
<td>Uranus</td>
<td>Pea</td>
</tr>
<tr>
<td>Neptune</td>
<td>Small plum</td>
</tr>
<tr>
<td>Pluto</td>
<td>Large orange</td>
</tr>
</tbody>
</table>

How far away is the Moon from Earth?

Earth               Moon??

or

Earth     Moon??

As early as the second century B.C., a Greek astronomer called Hipparchus, calculated the distance of the Moon as being 29.5 Earth diameters away. The accepted estimate today is 30 Earth diameters which highlights the accuracy of his work with the use of very basic tools.

Laser beams directed at the Moon and reflected from prisms placed there by Apollo astronauts can very accurately determine the Earth-Moon distance which has revealed that the Moon is slowly moving away from us at about 3 centimetres a year. The laser beam only takes 1.2 seconds to reach the Moon at the speed of 300 000 kilometres per second.

Equipment needed
1. Scale models of the Earth (about 12 centimetres in diameter) and the Moon (about 3 centimetres in diameter).
   * Inexpensive ‘squeeze-ball’ varieties can be purchased from speciality shops and are close enough to scale size to be used in this demonstration.
2. Clothes line rope (cut a length of 3.84 metres).

What to do
1. Ask for two student volunteers.
   Student A holds the Earth as well as one end of the rope
   Student B holds the other end of the rope.
2. Using a third volunteer to move the Moon along the rope, ask the class to suggest where the Moon should be placed on the rope to show the Earth-Moon distance.

3. Demonstration

Extraterrestrial life? What might its DNA look like? Have you ever wondered what DNA looks and feels like?

Every living thing contains DNA, the blueprint of life. If scientists in the future find life on Mars, they will examine it for the presence of DNA.

Extract DNA from strawberries using the following steps:

1. Place a sliced *strawberry* into a sealable *plastic lunch bag*. Squash out most of the air from the bag. Mash the strawberry for about 5 minutes.
2. Add 2 teaspoons of *detergent or shampoo* and mix it with the strawberry for another 5 minutes. Mixing the strawberry with the detergent helps destroy the membranes of the strawberry cells and physically breaks apart the cell walls. The detergent allows the DNA to get out of the strawberry cells by dissolving the fats and proteins that hold cells together.
3. Add 4 teaspoons of *salt* and some *warm water* into the plastic bag (not too much or the bag will be too full) and continue to gently mix together for another 5 minutes. The salt makes the DNA strands stick together.
4. Place a piece of *Chux™ cloth* (not sponge) over a glass and carefully pour the strawberry mixture onto the cloth to filter it by allowing the liquid to pass through but keeping the strawberry solid on top of the cloth.
5. Keep the liquid in the glass. Discard the strawberry on the cloth.
6. Pour the filtered strawberry liquid into a *clear plastic cup or clear drinking glass*.
7. Gently pour some *chilled methylated spirits* (alcohol) very slowly down the side of the glass container to rest on top of the strawberry liquid. The alcohol will dissolve everything but the DNA. Because DNA is not soluble in alcohol, the other parts of the mixture stay in solution. Freezing the alcohol increases the amount of DNA extracted.
8. Let the solution sit for about 5 minutes without disturbing it. The DNA will appear as whitish, slimy mucus-like strands that can be gently scooped out with a *cotton bud* or a *hook* simply made from bent wire. What does the DNA feel like? What does it look like? Describe your observations.

Can a small space rock cause damage on impact?

Even small space rocks travel very rapidly in space and can cause serious damage if they strike a spacecraft even if they are extremely small like dust. The amount of damage is determined by the size and the speed of the space rock.

**Challenge:** Try to push a *straight drinking straw* through a *raw potato*. Did you find it difficult? Did your straw bend?

Now hold your thumb over the end of the straw and jab rapidly at the potato. Was your attempt to penetrate the potato more successful? With practice, you can make the straw go all the way through the potato.

The rapidly moving straw easily passes into the potato. This damage to the potato is similar to the effect of a small piece of space rubbish colliding with a spacecraft.

4. Science Magic

Science ‘Magic’ using the Chemical in Disposable Nappies/Diapers

When discussing how astronauts cope with passing urine, if necessary, during a launch to space, or returning from space or during space walks, a simple experiment using the super absorbent chemical called sodium polyacrylate in disposable nappies appears to be ‘magic’ to mystify observers. This demonstration can easily explain why disposable nappies are useful to astronauts in space, although they are not worn during normal activity within a spacecraft or the International Space Station unless the toilet breaks down. NASA calls disposable nappies (or diapers) Maximum Absorbency Garments or MAGs.

Instructions (Always trial the experiment beforehand to assess the chemical quantity required.)

1. Try to remove some **white powder from a disposable nappy/diaper** designed for night wear. About one teaspoonful is desirable. Without telling the observers, place some powder into the bottom of a foam cup. If it is too difficult to extract the powder, **cut some nappy/diaper** itself and place it into the bottom of the foam cup. Water absorbing crystals for soil moisture treatment purchased from a plant nursery are also very useful and work well even though the crystals are large. If you have bulk sodium polyacrylate powder in store, then use that. You have now prepared the ‘magic’ foam cup. Both chemicals are non-toxic.

2. Fill another foam cup with water and ask the observers what would happen if a pencil or pen is pushed into the cup. Connect this to their understanding of gravity. N.B. Swirl this first cup to ensure similarity of procedure for the second foam cup.

3. Make the hole over a sink or outside the building to show that the water will flow out as a result of the pull of gravity.

4. Now explain that you will need another foam cup to demonstrate the gravity effect again. This time you use the ‘magic’ foam cup in which you have secretly placed the water absorbing chemical prior to the activity. Fill the cup with water. Gently swirl the cup to ensure that the powder can efficiently absorb the water.

5. Drill the pencil into the cup and withdraw it. Ask the observers to explain what might have happened. Connect this demonstration to why disposable nappies are very useful to astronauts and young children.

6. The opportunity to feel the gel inside the cup is always enjoyed.

© Jeanette Rothapfel
“Willing” a coin to move on top of a bottle
‘Science magic’ for convection of heat

This is a very simple demonstration which the students can undertake afterwards.

1. Using an empty glass bottle, place a coin that has been dipped in water on the opening of the bottle. I usually use a 10 cent coin and a small bottle for more a rapid result. I prefer to use a glass bottle so that the inference is not that you are squeezing the bottle to make the coin move.

2. Place your hands around the bottle and explain to the students that you are going to will the coin to move, i.e., mind power only.

3. The students must be quiet to allow them to hear any result of your ‘willpower’.

4. The coin will move and make a sound. Ask the students to explain this result. If necessary, guide the discussion by stating that the demonstration is actually based on a scientific concept. They should be able to suggest that the warmth from your hands heats the air within causing the heated air to rise. Expand the explanation by referring to ‘convection.’ Also explain that the rising of the air is caused by the expansion of the air from the hands’ heat making the air molecules move faster and further apart. Therefore, the air becomes less dense and rises. The moving coin is a result of the rising, heated air escaping.

5. Alternatively, you can use an empty plastic bottle that has been kept in the freezer. Place the wet coin on the mouth of the bottle and observe the result without placing your hands around the bottle. The cool air within becomes naturally heated and rises. However, this cannot be used again because the bottle needs to be very cold.

In both cases, the air will become heated, expand, rise and move the coin on top of the bottle.

© Jeanette Rothapfel
‘Science magic’ activities demonstrating surface tension

Instructions

Moving pepper across the surface of water with a ‘magic’ finger

1. Shake some pepper onto a bowl or cup containing water until the surface is well covered with pepper. Do not move the bowl or cup.
2. Ask a student to place their finger onto the surface and observe any change. There should be NO change.
3. Now suggest that your finger is ‘magic’.
4. Place your finger that had been previously rubbed on soap onto the water surface. Now observe the change.
5. The pepper will rapidly move away from your finger due to the soap (or detergent).

Why?

1. Water molecules form bonds with other water molecules. The bonds are so strong that insects can walk on the surface without sinking. The surface tension of the water acts like a skin supporting the pepper.
2. The soap weakens and breaks the forces between the water molecules. As this occurs, the pepper moves to the side being dragged away from the soapy finger by the water molecules that have not been broken up.

Make tie-dyed milk – often called ‘magic milk’

1. Pour some whole milk over the bottom of a large plate, preferably white.
2. Add 3 drops of red food colour onto the milk.
3. Add 3 drops of blue food colour some distance away.
4. Add 3 drops of yellow on the milk, also some distance away from the other drops.
5. Do not move the bowl after adding the drops of food colouring.
6. Dip a cotton bud into detergent (your magic wand) and touch the surface of centre of the milk OR ask a student to lightly touch the centre of the milk. Nothing should happen.
   Now tell your class that your finger is magic (already having been dipped in detergent before the trick) and place your detergent covered fingertip in the centre of the milk.

A very simplified explanation

1. Since milk is mostly water, it has surface tension like a water surface. Surface tension involves water molecules at the surface attracting each other so tightly that the surface forms a kind of ‘skin’ that will allow insects to walk on it and
objects carefully placed on it to remain on the surface without sinking. Thus, surface tension causes the tightly attracted water molecules at the surface of the milk to act like a skin and also helps keep the food colouring to stay together.

2. The detergent breaks the bonds between the molecules of the water in the milk, so weakening the surface tension of the water, allowing the food colours to move throughout the milk. It also causes the molecules of the protein and fat in the milk twist and roll in different directions.

3. Additionally, the detergent forms clumps of molecules that push the molecules around the milk.

4. The mixing of the moving milk molecules and detergent causes swirling and mixing of the food colours.

© Jeanette Rothapfel
Appendix J

Principal Components Factor Analysis for Survey 2

FACTOR
/VARIABLES PreP11 PrePI2 PrePI3 PrePI4 PrePI5 PrePI6 PrePI7 PrePI8 PrePI9
PrePI10 PrePI11 PrePI12 PrePI13 PrePI14 PrePI15
/MISSING LISTWISE
/ANALYSE: PrePI1 PrePI2 PrePI3 PrePI4 PrePI5 PrePI6 PrePI7 PrePI8 PrePI9
PrePI10 PrePI11 PrePI12 PrePI13 PrePI14 PrePI15
/PRINT INITIAL EXTRACTION
/CRIERI: MINIMUM(1) ITERATE(25)
/EXTRACTION PC
/ROTATION NOROTATE
/METHOD=CORRELATION.

Factor Analysis

(DataSet) C:\Documents and Settings\ja929\My Documents\Jeanette RHD\Jeanette's Research 1c sav.sav

<table>
<thead>
<tr>
<th>Communality</th>
<th>Initial</th>
<th>Extraction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre PI 1</td>
<td>1.000</td>
<td>.446</td>
</tr>
<tr>
<td>Pre PI 2</td>
<td>1.000</td>
<td>.431</td>
</tr>
<tr>
<td>Pre PI 3</td>
<td>1.000</td>
<td>.514</td>
</tr>
<tr>
<td>Pre PI 4</td>
<td>1.000</td>
<td>.659</td>
</tr>
<tr>
<td>Pre PI 5</td>
<td>1.000</td>
<td>.444</td>
</tr>
<tr>
<td>Pre PI 6</td>
<td>1.000</td>
<td>.442</td>
</tr>
<tr>
<td>Pre PI 7</td>
<td>1.000</td>
<td>.569</td>
</tr>
<tr>
<td>Pre PI 8</td>
<td>1.000</td>
<td>.408</td>
</tr>
<tr>
<td>Pre PI 9</td>
<td>1.000</td>
<td>.469</td>
</tr>
<tr>
<td>Pre PI 10</td>
<td>1.000</td>
<td>.561</td>
</tr>
<tr>
<td>Pre PI 11</td>
<td>1.000</td>
<td>.571</td>
</tr>
<tr>
<td>Pre PI 12</td>
<td>1.000</td>
<td>.441</td>
</tr>
<tr>
<td>Pre PI 13</td>
<td>1.000</td>
<td>.581</td>
</tr>
<tr>
<td>Pre PI 14</td>
<td>1.000</td>
<td>.549</td>
</tr>
<tr>
<td>Pre PI 15</td>
<td>1.000</td>
<td>.488</td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis.
### Total Variance Explained

<table>
<thead>
<tr>
<th>Component</th>
<th>Initial Eigenvalues</th>
<th>Extraction Sums of Squared Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>% of Variance</td>
</tr>
<tr>
<td>-----------</td>
<td>-------</td>
<td>---------------</td>
</tr>
<tr>
<td>1</td>
<td>6.583</td>
<td>43.888</td>
</tr>
<tr>
<td>2</td>
<td>1.161</td>
<td>7.738</td>
</tr>
<tr>
<td>3</td>
<td>.651</td>
<td>6.343</td>
</tr>
<tr>
<td>4</td>
<td>.875</td>
<td>5.831</td>
</tr>
<tr>
<td>5</td>
<td>.840</td>
<td>5.600</td>
</tr>
<tr>
<td>6</td>
<td>.729</td>
<td>4.859</td>
</tr>
<tr>
<td>7</td>
<td>.610</td>
<td>4.095</td>
</tr>
<tr>
<td>8</td>
<td>.563</td>
<td>3.753</td>
</tr>
<tr>
<td>9</td>
<td>.495</td>
<td>3.309</td>
</tr>
<tr>
<td>10</td>
<td>.433</td>
<td>2.887</td>
</tr>
<tr>
<td>11</td>
<td>.424</td>
<td>2.824</td>
</tr>
<tr>
<td>12</td>
<td>.405</td>
<td>2.702</td>
</tr>
<tr>
<td>13</td>
<td>.358</td>
<td>2.385</td>
</tr>
<tr>
<td>14</td>
<td>.310</td>
<td>2.054</td>
</tr>
<tr>
<td>15</td>
<td>.263</td>
<td>1.752</td>
</tr>
</tbody>
</table>

### Total Variance Explained

<table>
<thead>
<tr>
<th>Component</th>
<th>Extraction Sums of Squared Loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>% of Variance</td>
</tr>
<tr>
<td>1</td>
<td>43.888</td>
</tr>
<tr>
<td>2</td>
<td>7.738</td>
</tr>
<tr>
<td>3</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis.
Component Matrix

<table>
<thead>
<tr>
<th>Component</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre PI 1</td>
<td>.668</td>
<td>.007</td>
</tr>
<tr>
<td>Pre PI 2</td>
<td>.65</td>
<td>.082</td>
</tr>
<tr>
<td>Pre PI 3</td>
<td>.713</td>
<td>.072</td>
</tr>
<tr>
<td>Pre PI 4</td>
<td>.691</td>
<td>.275</td>
</tr>
<tr>
<td>Pre PI 5</td>
<td>.662</td>
<td>.074</td>
</tr>
<tr>
<td>Pre PI 6</td>
<td>.658</td>
<td>.091</td>
</tr>
<tr>
<td>Pre PI 8</td>
<td>.691</td>
<td>.149</td>
</tr>
<tr>
<td>Pre PI 9</td>
<td>.735</td>
<td>.136</td>
</tr>
<tr>
<td>Pre PI 10</td>
<td>.726</td>
<td>.189</td>
</tr>
<tr>
<td>Pre PI 12</td>
<td>.656</td>
<td>.127</td>
</tr>
<tr>
<td>Pre PI 15</td>
<td>.657</td>
<td>.220</td>
</tr>
</tbody>
</table>

Extraction Method: Principal Component Analysis

a. 2 components extracted