A STUDY OF INFLUENCES AND EXPERIENCES CONTRIBUTING TO THE ATTITUDES OF A GROUP OF VOCATIONAL STUDENTS TOWARDS SCIENCE

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Doctor of Education Declaration

'I, Marian Joyce Hinwood, declare that the EdD thesis entitled "A Study of Influences and Experiences Contributing to the Attitudes of a Group of Vocational Students Towards Science" is no more than 60,000 words in length including quotes and exclusive of tables, figures, appendices, bibliography, references and footnotes. This thesis contains no material that has been submitted previously, in whole or in part, for the award of any other academic degree or diploma. Except where otherwise indicated, this thesis is my own work.'

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Abstract

This research project examines perceptions and attitudes towards science of a group of Technical and Further Education students studying Beauty Therapy at Victoria University. Many members of this group displayed a high level of science anxiety as described by Mallow, (1978). They lacked confidence in their science ability and were very anxious about passing the science units in their Beauty Therapy courses, despite having successfully passed science subjects at school. Previous observations on Beauty Therapy students showed that most succeeded in their science units but still lacked confidence in their ability to apply their knowledge. The science units in Beauty Therapy are complex and require a detailed knowledge of Human Biology, Anatomy, Physiology, Skin Biology, Cosmetic Chemistry, and Microbiology. The participants in the study were interviewed using a semi-structured interview working together with a questionnaire to establish background information. The probes covered the participants' experiences in science at school together with their attitudes towards science and influences from other areas. The aim was to identify factors which undermined the confidence of these participants. The interviews were recorded and the transcripts were analysed for themes using a progressive coding process. The themes were grouped into clusters. The study showed clearly that the participants' confidence in their science ability was undermined by their school experiences in science. It related to attitudes and pedagogies employed by a particular science teacher in their secondary school. Participants described enjoying science previously. Particular aspects identified were an inability to get help when they needed it; the use of sarcasm or derogatory remarks to discourage questions; boring lessons mostly composed of copying notes from the board or textbooks; lack of relevance and a lack of enthusiasm displayed by the teacher. This led to a situation where participants dreaded their science lessons and in some cases truancy.

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CHAPTER 1: INTRODUCTION

The research project

This research project examines the perceptions and attitudes towards science of a group of students studying in Beauty Therapy at Victoria University and explores some of the factors which contribute to the development of these attitudes and perceptions. It arose from observations made by the researcher while teaching science to Beauty Therapy students.

The Beauty Therapy curriculum

Beauty Therapy courses are offered at several colleges of Technical and Further Education (TAFE) and also by several cosmetic manufacturers. There are no formal requirements in the industry for practicing beauty therapy but people with qualifications in this area have an improved chance of employment compared to those without qualifications.

The intake to the Beauty Therapy courses at Victoria University is generally from thirty to fifty students at Certificate II level twice yearly plus an additional intake at Certificate III level. There are no formal academic requirements for entry to Certificates II and III in Beauty Therapy and students are selected by interview and on the basis of any relevant prior learning experiences.

The courses available at Victoria University in Beauty Therapy range from Certificate II to Diploma Level. The curricula for these qualifications are set out by the Victorian government and include study of a number of different science subjects including Skin Biology, Human Biology, Anatomy and Physiology, Microbiology, Cosmetic Chemistry and Physics depending upon particular areas chosen. Skin Biology, Human Biology, Anatomy and Physiology and Microbiology are core components of the course and are required study areas. The science curricula areas are complex and advanced particularly in respect to Cosmetic Chemistry, Skin Biology and Anatomy and Physiology. Students studying for Certificate II in Beauty Therapy are required to study Human Biology, Microbiology and Skin Biology. Students studying for Certificate III or a Diploma of Beauty Therapy are required to study Microbiology, Anatomy and Physiology and Skin Biology. Those students wishing to specialize in the area of cosmetics and make-up also study Cosmetic Chemistry. Cosmetic Chemistry requires study of the many different compounds used in cosmetics including their functions and effects on the skin and possible side effects. In addition, it is necessary to know which compounds react together or nullify the effects of other compounds. Those students intending to specialize in the areas of electrolysis or laser therapy also study Physics.

The Skin Biology course includes a detailed study of the different layers of skin including the different cell types involved, and types of tissue, in addition to the composition of the extracellular matrix, including the structure and formation of the different proteins and other compounds found in this matrix such as collagen and proteoglycans. It also involves the study of different skin types and various abnormalities and diseases of the skin and where relevant, how the beauty therapist may treat or improve these.

The Human Biology course at Certificate II level includes a basic knowledge of both anatomy and physiology. The anatomy requires detailed knowledge of the various body systems especially the skeletal and muscular systems as beauty therapists often perform facial and scalp massage. The physiology course covers function and operation of the various body systems including muscle contractions and nerve impulses as well as the process of digestion and the importance of various nutrients. At Certificate III and Diploma level, the Anatomy and Physiology course is more advanced and includes some

biochemistry and detail of enzyme function. The Skin Biology course is also more advanced at Certificate III and Diploma level including areas such as vitamin D production in the skin and the effect of sun on skin and the various skin pigments and their formation.

Because of the importance of hygiene and safety all beauty therapists have to have an understanding of micro-organisms and their role in skin infections and their Microbiology course includes study of the main classes of pathogenic micro-organisms, such as bacteria and viruses as well as a knowledge of fungal spores which cause conditions such as tinea and ringworm.

Taken together, these science courses involve a considerable knowledge base which many Beauty Therapy students find formidable. Students are required to obtain a pass of at least seventy-five percent in their science courses in order to proceed to the next level.

Factors behind the research project

While teaching science subjects to the beauty therapy students, the researcher became interested in the area of confidence in science ability. What was very striking was how low the confidence levels of many of the Beauty Therapy students were in their ability to succeed in the science units of their Beauty Therapy courses. Previously the researcher had taught science units in Laboratory and Medical Technology courses both of which require passes in the Victorian Certificate of Education as a minimum entry requirement. That is, a successful completion of Year 12 was required for these courses. Initially, the researcher had expected to find that the level of ability of the beauty therapy students was lower than most of the students she had taught science to previously as the entry requirements were considerably lower for Beauty Therapy than for those other courses. However, it was rapidly found that this was not the case. The observed lack of confidence of the Beauty Therapy students was not merited as not only did most of the Beauty Therapy students pass their science, but they did very well and achieved high passes in their examinations. Hence the researcher became increasingly interested in what caused this lack of confidence which seemed to relate specifically to science. This led to the researcher exploring published research in this area and identifying it as 'science anxiety' – a term coined by Mallow, (1978). (See pages 13 and 26 for more detail). A similar condition has been described in relation to the study of Mathematics. However the researcher was unable to find information on how the condition develops and thought it was possibly due to students not being taught science by their preferred learning style. There is a large volume of published literature on science anxiety and also on the attitudes of students to science. These areas are discussed in detail in the literature review. The researcher then started questioning some of her students informally about their science experiences and backgrounds. This led to formulating the current research project.

Background to the research

The students within the Beauty Therapy classes may range in age from sixteen to sixty (or more), and are predominantly female. Academic levels and generic skills of these students range from Year 9 secondary education to university graduate, with the majority at Year 10 to Year 12 secondary education. Students have a minimum of two three hour sessions of science a week throughout their course. Classes are fairly large averaging twenty five students per class.

Most Beauty Therapy students taught by the researcher expressed very low levels of confidence in their ability to succeed in the science components of their Beauty Therapy course. At the start of each new

science unit before the subject had even been introduced, the researcher was surrounded by students stating that they would fail and that they could not 'do' science. By this phrase they meant that they perceived themselves as being unable to understand science or to succeed in any study of science. There were actually some students who were so sure that they would fail that they changed courses when they found that science subjects were a compulsory part of the course. In addition, Beauty Therapy students had low levels of general scientific literacy compared with other students the researcher has taught. This was shown by the fact that it was found necessary by the researcher to spend at least two sessions introducing elementary scientific concepts at the start of each new science unit or students had increasing difficulty in following the course. In addition, it was necessary to define many elementary scientific terms and words that the researcher had expected students at this level to be familiar with. Their general level of written literacy skills was low. Many of these students lacked computer access or computer skills as assignments were frequently hand-written not typed.

These observations are subjective and based on the researcher's own experience of teaching Beauty Therapy students. However, Masters and Forster for The Australian Council for Educational Research [ACER], (1997) have published data on the literacy and numeracy skills of Australian school children. This data shows that approximately 25% of students are leaving school with inadequate literacy levels and that this percentage has changed little since being identified in 1997 despite a number of initiatives designed to alleviate the problem (Rothman, 2002). Moreover the figures show a decline in literacy standards since 1975.

The researcher is convinced that while a small percentage of students studying Beauty Therapy at Victoria University are of limited academic ability, the majority are of average ability or higher. Experience with these students has shown for example, that they have a quick grasp of principles and applications once they have been provided with an introductory 'platform'. The laboratory work of Beauty Therapy students was exemplary and most students passed their science. It is difficult to assess the depth of their understanding, although any short course will have this drawback. Completion of their science units in the Beauty Therapy course should enable students to understand the role of science in their profession and where it can be useful to them. Also the students should be able to assess and understand the implications of new developments and published literature in their field. However, even those beauty therapy students who obtained distinction or credit level passes in their science units often did not seem to have confidence in their ability to use their knowledge.

Ideally, of course, science studies can open doors for students and the process of studying science can be both rewarding and enjoyable. Teaching science successfully requires that proficiency in basic language – technical or scientific literacy skill is required of students before concepts can be developed. Acquiring this language base is an area these students found difficult. This statement is based on the fact that many of the Beauty Therapy students complained of difficulties in learning and understanding technical words such as differentiation, contraction, protoplasm, or even names of body parts such as vertebrae and clavicle. The researcher was interested in exploring the reasons for the lack of scientific awareness and confidence displayed by these vocational students and to identify why these attitudes may have developed. The ultimate objective of this study was to gain an insight into the factors which have contributed to the current levels of scientific literacy and confidence displayed by these Beauty Therapy students. This study may also have implications for the future teaching of science in schools and for students who attain low levels of literacy in other subjects in school. The research aimed to document the students' science experiences as narratives and to find factors relevant to the ways in which they positioned themselves in and towards science.

Personal introduction by researcher

My science background as the researcher is in biochemistry which I have read to doctorate level. I have throughout my life been interested in education and have taught a variety of students at levels ranging from secondary through to tertiary. I financed my science qualifications by coaching and private tuition of a number of secondary students. For several years, I ran a tutorial group in mathematics and science on Saturday mornings from my home. I also worked as a demonstrator for Second Year Biochemistry and Physiology at Monash University. In addition, I ran Girl Guide and Brownie units for more than twenty years which gave me considerable experience of working with young people. I completed a Diploma of Education in 1993 and since then moved away from biochemical research and into teaching - initially in Technical and Further Education (TAFE), and more recently at Victoria University where I teach science education and some education units. I taught science at TAFE for eight years. At Huntingdale College of TAFE, I taught Year 11 Physics. I went from there to Chisholm College of TAFE where I was teaching Chemistry and Anatomy and Physiology to students undertaking courses in Laboratory and Medical Technology. At this time, I also started working with students studying Beauty Therapy and Massage at Victoria University on the King St City campus of Victoria University (which was then a TAFE college). There I taught science units to students studying a range of levels from Certificate II through to Diploma level in Massage and Beauty Therapy. I have completed the course work requirements for a Doctorate in Education.

The research questions

This research was structured around the following questions:

1. What experiences in learning have contributed to the development of poor confidence in the ability to do* science and to the low levels of scientific literacy among students studying Beauty Therapy at Victoria University?

2. What other experiences may have contributed to the low levels of scientific awareness and confidence displayed by these Beauty Therapy students?

3. Which of these factors are common to the group as a whole?

*Students used the phrase ‘I can’t do science’ as an expression of their perceived inability to succeed in science studies or to understand it, and this is the intended sense here.

Note: It was determined to investigate previous experiences in learning as students presented at initial meeting with a lack of confidence and in many cases considerable anxiety and fear about studying science

Science anxiety

‘Science anxiety’ is a term coined by Mallow, (1978), to describe the phenomenon of a person experiencing extreme anxiety and a fear of failure when required to do science in any form. This anxiety was evident even in people who had successfully completed science courses. They continued to feel anxious with a lack of confidence in their ability to use their knowledge. Mallow himself was interested in

treating the anxiety and most research has been directed towards contributing areas. The Beauty Therapy students are a group which displays high levels of lack of confidence and many of them express extreme anxiety when they realise that science units are a requirement of their courses. The researcher was interested in the aetiology of the lack of confidence and anxiety displayed by these students, that is, what factors caused it to develop. The study therefore explored the science experiences and influences on the group of participating Beauty Therapy students and looked at aspects of their family background, home environment, first language, and family position in addition to formal and informal experiences in learning science.

Scientific literacy

For the purposes of this research, scientific literacy was defined by the researcher as: knowledge of basic scientific knowledge and concepts together with an ability to apply these. There was no formal measurement taken of scientific literacy of the participants as this was not practicable. The level of scientific literacy shown however by the Beauty Therapy students in class was considerably lower than that of other science students the researcher had taught and it was necessary to define many words and terms for these students that the researcher expected a student at tertiary level to know. Further discussion regarding the definition of scientific literacy is on pages 21 and 22.

The research design

Students studying Certificates II and III in Beauty Therapy at Victoria University were invited to volunteer as participants in the research project. Those students who volunteered were then interviewed about their science experiences both in formal education and informally from sources outside the school environment such as family or media. The interviews were recorded and transcripts were analysed for dominant themes. All interviews were conducted by the researcher working from a list of open ended questions and probes into the relevant areas. Care was taken to ensure consistency between interviews in the areas probed, while also allowing sufficient latitude for respondents to tell their stories as they unfolded. The interview procedure is detailed in Chapter 3, Methodology. These considerations enabled conclusions to be drawn which address the research questions and also point to ways of improving the current situation. The analysis is presented in detail in Chapter 5 (Themes Extracted from the Interviews) and Chapter 6 (Discussion and Conclusions).

The importance of the research

It is generally accepted that it is important for people to develop scientific literacy in today's world. Grayling, (2008, p. 55), states: 'Scientific literacy lets us take an informed and hence responsible stance on issues that vex society.' The observations on the Beauty Therapy students show that able students are graduating from school lacking basic scientific literacy and moreover, lacking the confidence in their ability to address this. Data on the ways in which students develop their perceptions of and attitudes towards science provides valuable information enabling adverse influences to be identified and minimised in the future. These factors may also be relevant to the fact that there has been a decline over the past two decades in the number of students electing to study science and mathematics, (Adams, Doig and Rosier, 1991; Tobias, 1990). Moreover of those students who do elect to study science in school, relatively few proceed into tertiary science study, (Dobson, 2003). This is a phenomenon which appears to have developed worldwide and appears more prevalent in the more affluent countries,

(Reiss, 2007). The Programme for International Student Assessment [PISA] and Trends in International Mathematics and Science Study [TIMSS] are international assessments carried out to assess standards, attitudes towards science and levels of scientific literacy of schoolchildren. The most recent of these studies, (PISA, 2009 and TIMMS, 2007) also confirm this trend

The Relevance of Science Education (ROSE) project is an international project designed to shed light on factors of importance in the learning of science and technology –as perceived by the learner. The ROSE project was initiated in 2004 by Schreiner and Sjoberg at the University of Oslo and is ongoing and now involves researchers from universities and government institutions in more than forty different countries. To date it has studied many thousands of children in these countries and has shown that despite heavy investment in school science, by the age of fifteen, most students have been turned off science. This is despite there being a keen interest shown in science by eleven year olds. It is clearly important to understand what happens to students to destroy the earlier interest and confidence levels, they experience at age eleven.

It is important to elucidate factors which may contribute to low confidence levels in any subject, but particularly in science and mathematics as the demand for technology and its artefacts has never been higher. Moreover both subjects carry a considerable body of conceptual and factual knowledge which is to some extent consecutive. This means that once a student does fall behind or even fails to understand a particular topic, they have difficulty 'catching up'. It is therefore of crucial importance to understand what happens to students to elicit low scientific literacy levels and lack of confidence so that steps can be taken to minimise these effects in the future.

Although the sample size in this study was relatively small, the science stories of the participants do show some factors involved in the development of these attitudes. This research has the potential to improve the teaching of science and possibly other theoretical subjects by identifying factors which are important in determining the outcomes of student learning of science subjects.

In a climate of economic rationalism, where there are few jobs for low-skilled youth, there is an increasing need for all students to obtain higher education, and it is vitally important that students obtain the maximum benefit from their education. (Ellyard, 2001) discusses the importance of education in a global context and refers to lifelong learning as a concept to be developed.

Overview of the thesis

The next chapter discusses a synthesis of the relevant literature including literature related to early learning influences and theories of learning, gender influences, school influences, and government initiatives. There are also sections on science learning and literacy, science anxiety, cultural influences and motivation and relevance.

Chapter 3 describes in detail the research design and the methodology used. It also describes how themes were extracted from the data and how these themes were then categorized.

Chapter 4 contains the science stories of the participants.

Chapter 5 is a discussion of the themes that arose from the participants' stories.

Chapter 6 discusses the results of the research and presents the conclusions drawn from the research together with recommendations that follow from these conclusions.

Finally there is a list of the references used in the work.

The appendices contain the various forms and procedures including an information form for participants, a consent form for participants together with a form that participants completed providing background information and a list of the probes used during the interviews.

CHAPTER 2: LITERATURE REVIEW

Overview

The following review of the research literature was synthesised in relation to the research questions. This research examines the development of attitudes towards science in a group of Technical and Further Education (TAFE) students. The aim of the research is to identify factors which are important in the development of positive attitudes towards science and confidence in the ability to use and apply scientific concepts and learning. The research is important in emphasizing factors known to be important in the teaching of science and highlighting areas where science teaching may be improved. A number of studies have shown a correlation between student attitudes towards science and science performance, (Linn, 1982; Weiss, 1987), with students who have positive attitudes towards science consistently outperforming those students who have a poor attitude, (Cannon and Simpson, 1985). An international study of the influence of attitudes to science on performance in nine year old and thirteen year old students in twenty countries was carried out in 1992. (International Assessment of Educational Progress [IAEP], 1992). It showed that a positive attitude resulted in better performance in science studies. This finding was also shown in the more recent international studies which are discussed in detail on pages 21 to 23 (PISA, 1997, 2000, 2003, 2009; TIMMS, 2003, 2007). These surveys emphasise the importance of the current study in elucidating factors which are relevant to determining student attitudes towards science.

These attitudes towards science develop as a result of experiences undergone by the child during development. While there is some influence from the cultural capital a child carries and external issues such as family background, the main experience of science comes from school science lessons. Hence these lessons have a crucial impact on the attitudes a child develops in relation to science and the level of the child's confidence in their science ability. Most definitions of scientific literacy (see pages 21-22) imply confidence in the ability to use and apply scientific knowledge and concepts.

A number of different areas are involved in science learning. These include the ways in which children learn and modify their existing concepts, the pedagogies employed to teach science together with the attitudes of both students and teachers and the relationships between these. It has been shown that successful learning has a positive effect on both confidence and student attitude (Eccles and Wigfield, 2002).Therefore this synthesis has a large section on learning theory and its application to science teaching. Factors relating to underachievement and lack of confidence are also explored together with an overview of literature on science anxiety. Student motivation and attitudes are discussed and the importance of student/teacher relationships and their effects on student achievement. Research literature on the influence of teachers and the teaching practices they adopted is discussed with particular reference to the effects of these issues on student performance.

Other relevant issues are the current disinterest in science studies exhibited by school students and the importance of science understanding and scientific literacy in today's world. In addition, some government initiatives directed towards improving science education are discussed. Also some specific issues related to pressures and difficulties experienced by science teachers in Australia are explored, together with their impact on teaching practice.

Since a majority of the participants in the current study are female, published literature on gender issues is discussed. Finally, literature on possible influences on science attitudes due to cultural background is synthesised.

Early learning influences

Prior to entering school, the dominant influences on a child are those of home and family together with the external influences of pre-school and childcare, (Erikson, 1963). Erikson's theory of psychosocial crises has identified a number of stages through which an individual needs to pass in order to gain full maturity. Erikson postulated that the child needs a nurturing relationship with an adult to successfully pass through these stages. While in the early stages of life, these nurturing roles are carried out by parents and family and possibly early childhood carers and educators. However once a child starts school, much of this mentoring role is taken over by teachers and hence a student's relationships with their teachers are important determinants of their successful development The early school experience according to Erikson's theory is important in developing initiative, while the next stage in schooling is when competence is developed. Hence, it is crucial that the whole schooling experience is optimal.

Theories of learning and learning styles

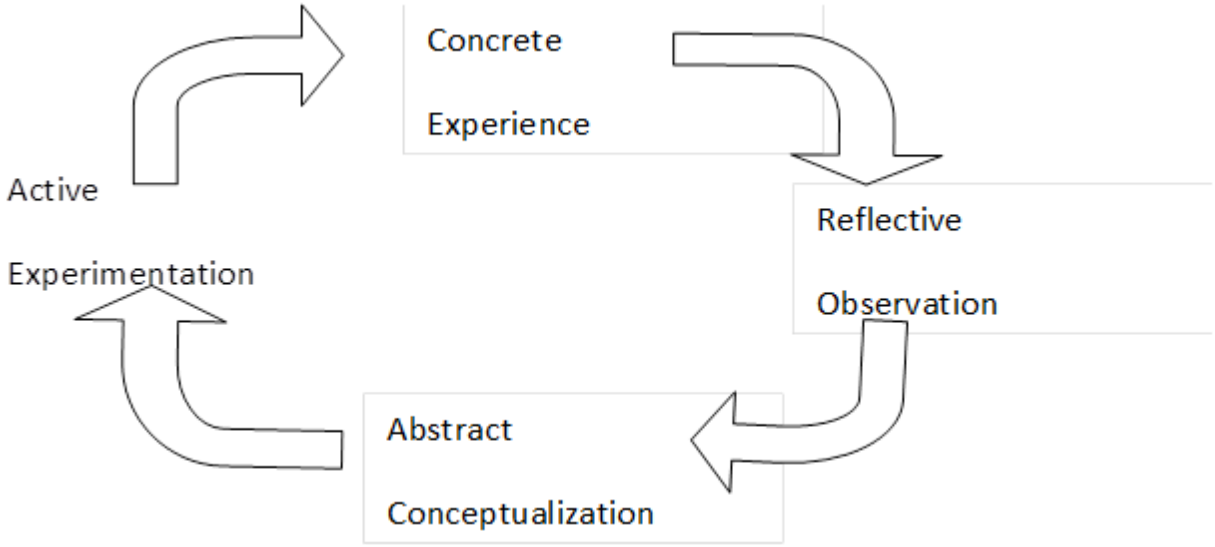
An underlying rationale of this research is that previous learning experiences, for the students in the current study were less than optimal, particularly with respect to science learning. Therefore, a synthesis of different theories of learning is presented below.

Historically, some of the earliest works on education were written by Comenius in the seventeenth century (as cited in Henry, 2004). Comenius believed that emotional growth and learning were interwoven with spiritual growth. He advocated learning through the senses, not just by memorizing and demonstrated this concept by using pictures in a textbook on foreign languages. Diagrams are a crucial part of aiding the understanding of science concepts.

Dewey, (1916) linked learning to the realisation of the consequences of an action. He saw it as having both active and passive components – an experience is undergone (passive), leading to some action (active), - the two processes being integrated into learning by recognition of the consequences of that action. Hence instructional design needs to make learning experiences meaningful and also comfortable for the learner in the sense that they feel it is within their abilities. Watson, (1928) proposed that human learning was mostly determined by experience and not genetically predetermined, so that he also saw learning as an experiential process.

The idea of experiential learning was further developed by Kolb, (1984). His theory has elements of Dewey's ideas, but extends them further. Kolb describes learning as a cyclical process. An experience is undergone, the learner reflects on the experience, and develops a concept. This is then followed by active experimentation to test the concept. (See Figure I). That is, Kolb sees learning as an experiential process but effective learning requires all four stages to be completed.

Figure 1: Kolb's Learning Cycle (Kolb, 1984)



The scientific method is based on observation leading to hypothesis which is tested by experiment and further application and this relates closely to the ideas described above. Hence they have relevance to the science experiences of the group of TAFE students in the current research.

Honey and Mumford, (1992) suggested that there was a learning style for each stage of Kolb's cycle and postulated that people had a preferred stage which dominated their learning processes. This led to the idea of four types of learner: activists, pragmatists, reflectors and theorists. Later work by Kolb, Osland and Rubin, (1995), resulted in the development of a technique for learners to assess their own preferred learning style.

Felder and Silverman, (1988) conducted a longitudinal study running over several years and involving several thousand first year engineering students in which they measured the preferred learning styles of the students. They also measured the preferred teaching styles of their lecturers and then trained the lecturers to teach in a manner consistent with the preferred learning styles of the students. There was a significant increase in the performance of the students when this was done. It was expected that preferred learning styles would have a dominant influence on the science experiences of the TAFE students interviewed in the current research and this area was probed with them in the interviews.

Gestalt Theory, (Wertheimer, 1923), concerns problem-solving and understanding concepts. Wertheimer suggested that some ideas could only be understood in terms of a 'bigger picture'. This means that the relevance and context of a problem or concept are necessary to understand it. This is very important in the teaching of science as a number of researchers have shown that students lose interest when they cannot see the relevance of the concepts they are studying, (Goodrum, Hackling and Rennie, 2001; Lindahl, 2003b; Osborne and Collins, 2001).

A quantitative approach to learning was taken with Information Processing Theory (Miller, 1956). This was based on the fact that short term memory is thought to be able to hold between five to eight pieces of information at any one time and hence information should only be provided in relatively small bites. The researchers mentioned in the previous paragraph, (Goodrum et al 2001; Lindahl, 2003b; Osborne

and Collins, 2001), have all shown that students are disengaged and in many cases overwhelmed by large amounts of note-taking from the board or from lectures.

The Theory of Constructivism has been described as a way of knowing, (Tobin, Tippins and Gallard, 1995), and ultimately states that all knowledge is a construction. It provides an approach to teaching which aims to modify existing constructs and conceptual ideas. It derives from several learning theories. Constructivist Theory, (Bruner, 1960), states that people actively construct knowledge by comparing new concepts and ideas with their existing knowledge and modifying them accordingly. Piaget, (1971) developed a constructivist theory of cognitive development which involves assimilation of experience followed by accommodation of that experience and then adaptation of behaviour. Knowledge or learning is than constructed progressively through a sequence of behavioural or mental processes.

Vygotsky, (1978) also developed a theory of cognitive development but his theory included social interaction. Constructivism as a teaching approach uses social interaction by way of guided discussion between peers to develop or modify constructs. In Vygotsky's model of cognitive development, some skills a learner can learn independently; to learn other skills, a learner may require assistance. This area where assistance is required, Vygotsky defined as the Zone of Proximal Development. It is very important in education as this is the zone in which educators operate. It led to the concept of scaffolding instruction to suit the learner. Scaffolding is a technique which proceeds in stages. Initially the teacher aims to make connections between what the child already knows and what is desired to be learnt. Then, by a process of keeping teaching within the stage of the child's cognitive development, learning proceeds to the point where it can be self-directed with the child asking for help when they need it.

Bandura, (1986) also believed in the importance of social interaction but he saw it more as behaviour being learnt from the observation of others. This is the way in which infants and small children learn and it is a concept used often in teaching practice, for example, demonstrations and examples worked on the board.

Gagne, (1970) developed a model of instruction initially for instructing pilots in World War II but subsequently for children. His method was based on the concept that different kinds of learning, for example, motor skills compared to literacy skills, needed different teaching approaches or strategies. His work was the precursor of the 5Es strategy. This is a constructivist teaching technique which was developed by Bybee, Harms, Ward and Yager, (1980). The strategy involves a consecutive approach aiming to initially engage students in a topic, and then allowing them to explore the topic, develop explanations, evaluate what they have learnt and extend it. Bybee et al developed the strategy as part of developing a framework for science teaching in America. Rogers, (1983) also described the different types of knowledge and distinguished between academic knowledge and experiential knowledge. Importantly in the context of the current research, he saw experiential knowledge as a skill or learning that is acquired by the learner to meet their needs. That is, it has relevance to them in their daily life.

Other educators have observed the phenomenon under investigation in this project – in which students of apparently normal abilities fail to achieve optimal outcomes from their education. Gardner, (1983) developed a theory of multiple intelligences, which identifies eight areas of intelligence: verbal, logical, visual, musical, bodily, interpersonal, intrapersonal, and naturalistic. Gardner suggested that different people have a different dominant intelligence. This led to Gardner and Hatch, (1989) suggesting that education should be geared towards these different intelligences, not just towards the academically gifted.

Taken together, these various theories of learning portray learning as an experience which:

1. Engages all senses of the learner in a secure and nurturing environment.
2. Offers material to the learner by several different modalities
3. Provides opportunities for the learner to engage in and experiment with the material enabling the learner to develop and extend their construct of the underlying knowledge.
4. Provides opportunities for students to engage in guided discussions with their peers on topics under study.

True learning also entails viable application of the learning to other situations. Therefore a teacher needs to set up appropriate learning situations and scaffolding to ensure optimal learning for their students, together with demonstrating the relevance and potential application of that learning.

Scientific literacy and science learning

There is general agreement that students growing up today need to be scientifically literate in order to make informed decisions about scientific issues, (Goodrum, Hackling and Rennie, 2001). Bybee, (1997 p. 46), suggests that scientific literacy for all students should be 'the fundamental goal' of science education. Perusal of any daily newspaper shows the importance of science education today as it highlights the sorts of issues that people need to be informed about. Ideally, this means that all students should leave school with a reasonable level of scientific literacy. This includes awareness of science content knowledge and of the science inquiry process enabling people to function as competent citizens. Dewey, (1916) saw learning as conferring the capacity for continued growth and scientific literacy and learning enables this.

There are two main international studies carried out on students: The Programme for International Student Assessment [PISA] and Trends in International Mathematics and Science Study [TIMSS]. PISA has a three year cycle. The programme was developed by the Organisation for Economic Cooperation and Development [OECD] and in Australia the assessment is conducted by the Australian Council for Educational Research [ACER].The studies have been conducted on fifteen year old students. The TIMMS studies were carried out on Year 8 students who were younger on average than those in the PISA studies. TIMMS has a four year cycle and was developed by the International Association of Student Achievement. Both studies assess mathematical and scientific literacy together with information on students and schools. However the aims of the two studies are different. These differences are reflected in the assessment tools used in the two studies. The main aim of the PISA study is to determine whether young people have acquired sufficient levels of reading, scientific and mathematical literacy to enable them to function well in adult life. In addition, the study aims to show the factors which enable these skills to be developed both at home and at school. This knowledge then impacts on policy development. The TIMMS studies are primarily concerned with the teaching of science and mathematics and collect information on international variations in curricula, teacher training, textbooks, actual course content, different instructional practices including the effects of tracking and streaming of students and how these factors relate to student achievement. They also investigated attitudes of teachers and students. The assessment of students in these studies therefore included questions on their attitudes towards science.

The two most recent PISA studies which were carried out in 2006 and 2009 respectively used a definition of scientific literacy which was broader than that used in previous PISA studies and included attitudes

towards science in addition to cognitive abilities and knowledge. This recent definition includes the following points, McRae, (2006, p.22):

- scientific knowledge and use of that knowledge to identify questions, to acquire new knowledge, to explain scientific phenomena, and to draw evidence-based conclusions about science-related issues
- understanding of the characteristic features of science as a form of human knowledge and enquiry
- awareness of how science and technology shape our material, intellectual, and cultural environments
- willingness to engage in science-related issues, and with the ideas of science , as a reflective citizen

Although, the results of the PISA surveys carried out in 2000, 2003, 2006 and 2009 by ACER, of literacy, numeracy and scientific literacy showed that Australian students rated highly compared with students from other countries, the students, whose scientific literacy was assessed, were students studying science. This study was based on testing of students at lower and middle school levels in randomly selected schools. The TIMSS study (2003) showed that Australia has slipped down in the international rankings. The results from the most recent TIMSS study, (2006) were released in 2007 and showed that while there has been a marginal improvement in Australia's position, it reported poor student attitudes towards science and a drop in university enrolments in science. According to the survey, 13% of Australian 15 year olds fall below the OECD scientific literacy baseline. For rural students this figure rises to 27% and for aborigines it is 40%. For students from low socio-economic backgrounds, it is 23%. As far as the researcher can establish, there have been no assessments of scientific literacy in the Australian school population as a whole.

A number of reports (Hanrahan, Cooper and Russell, 1997; Ministerial Council on Education, Employment, Training and Youth Affairs [MCEETYA], 2000 released in 2002), have expressed concern about the fact that the PISA study does not appear to translate into reality as, in practice, few students seem interested in studying science, and many students complete school without having studied any science at all, (Gold and Capponi, 1993 for National Board of Employment Education and Training [NBEET]).

There are a number of possible explanations for this. Interest is definitely a factor, as Tobias, (1994) showed that there was a correlation between topic interest in a subject and prior knowledge. If early grounding is inadequate then this prior knowledge may be absent leading to a 'switching off' of interest. Science is often seen as difficult, complex and relating to research and discoveries, rather than being of direct use to particular occupations. Breivik, (1998), working in the area of information literacy, has shown that skills are only practised when they are required to complete specific assessment tasks, and much the same is true for scientific literacy skills. Young and Harmony, (1999) point out that students are often taught information literacy before they have a need for it. Hence the information is not retained or is found difficult to master. This type of influence may also be relevant in science studies. Tobias, (1990) carried out a study to look at the reasons for students becoming discouraged with science. In this study, students were asked to monitor a mathematics or science subject for a semester and give feedback on their experience. Dominant findings from this study were that too much time was spent on mathematical problems and not enough time was spent on what scientists actually did.

In America, a similar situation of falling interest in science and a drop in scientific literacy has been causing concern. As far back as 1979, Harms, Bybee, and Yager, showed that students' attitudes towards science declined as they moved through school. Ebenezer and Zoller, (1993) looked at the influence of constructivist approaches to teaching science but found no significant improvement in student attitudes at Year 10. However Eisenhardt, (1977) showed a change in attitude followed an improvement in marks.

Student attitudes towards science

As mentioned above, both the PISA and TIMMS studies have shown a decline in student attitudes over the past three decades and this situation is reflected in both the United Kingdom and in the USA and other western countries generally. One significant finding of the PISA, 2009 study was that East Asian students (from China, Hong Kong, Japan and Korea), had very poor attitudes towards science although they consistently scored among the highest internationally on science achievement tests. This contrasts with the findings of both Eisenhardt, (1977) and that of Eccles and Wigfield, (2002), who showed that successful learning, has a positive effect on both attitude and confidence.

Lyons, (2006) carried out questionnaires and interviews on Year 10 students and although these students thought science was important, they were not interested in it for themselves. Lyons found that students who had strong background support from families were more likely to choose to continue with science. He concluded that the problem was largely in the nature of school science itself and the ways in which it was presented to students. Lyons noted that students were put off by boring and unnecessarily difficult content. This also agrees with the Relevance of Science Education (ROSE) project carried out by Sjoberg and Schreiner, (2005). This was an international investigation of student interest in science topics and school science. One finding of this study was that boredom with science course content in Swedish schools was so common that many students who initially intended to pursue careers in science found it so boring that they gave it up. Papanastasiou and Michalinos, (2004) studied student attitudes towards different science subjects in America, Australia and Cyprus and found that there was a positive correlation between students liking Biology and Chemistry but the students interested in these areas had a negative attitude towards Physics. They also found that liking a particular subject was related to peer perceptions of difficult and/or boring content.

There are a number of teacher related issues of importance to this research. Haladyna and Shaughnessy, (1982) and Lederman, (1992), looked at how the affective relationship is developed in science instruction. Haladyna and Shaughnessy carried out a meta-analysis of research on student attitude, between 1960 and 1980. Their aim was to develop an integrated model of attitudes towards science. They noted that there have been few studies with predictor variables relating to the teacher. Haladyna and Shaughnessy also reported that there was a consistently high relationship between student attitude and achievement with a positive attitude leading to high achievement.

Lederman, (1992) noted that a positive relationship between student and instructor was an important determinant of student success in a subject. Smith, (1990) studied teacher behaviour patterns that helped to develop positive cognitive and affective relationships and suggested that these patterns could be used to develop professional development models for science teachers.

An important aspect of school development in early adolescence particularly is associated with the social context, that is, the peer relationships of the adolescent. (Garner, Bootcheck, Lorr and Rausch, 2006;

Ryan, Kiefer and Hopkins, 2004; Wentzel and Watkins, 2004). Kindermann, (2007) and Wentzel and Watkins, (2002) have shown that within particular friendship groups, students have similar patterns of engagement and performance. These friendship groups are complex consisting of dyadic relationships embedded in larger groups, (Buckley, 2008).

Coleman, (1966) carried out extensive research in the area of educational opportunity primarily with the aim of reducing educational disadvantage for black children in American schools. His findings showed that even though schools in predominantly black areas received the same funding as those in predominantly white areas, the educational opportunities for the black children were fewer than those for children in white communities. This led to experiments bussing school children between black and white communities which ultimately failed to achieve the desired outcome of improving opportunities for black children because the parents of white children removed their children from the schools where this was carried out. The research also showed that provided their numbers were relatively small, black children had better outcomes when attending predominantly white schools. Subsequent research by Coleman and Hoffer, (1987) comparing public and private schools showed that communities had a big impact on their children's schooling and that children in disadvantaged areas received far less support from their school communities. This factor is also relevant in Australia where there are pockets of communities of low socio-economic groups.

School subcultures and positioning theory

There has been much media debate recently over the Victorian Education Minister's decision to rank schools on the basis of academic results, with a view to demanding better progress from those schools, which rank poorly on this index. In addition, another current discussion has been on the increasing trend of parents to remove their children from government schools and to send them to private schools, (Denniss, 2004). This move has been prompted by the fact that a higher proportion of children educated in private schools attend university, which is perceived to be a better result, (Harvey-Beavis and Robinson, 2000). In other words, university education is seen as superior to other forms of tertiary education. This attitude carried through into secondary schools inevitably directs education and pedagogy generally into forms that achieve successful university entrance. Joshua (1997) notes that vocational education will remain as a second-best option, as long as Tertiary and Further Education (TAFE) institutes are seen as places where students go after they have been rejected by universities.

The Kirby Report, (2000) noted that the current school system was not suitable for all. Many students leave school with inadequate qualifications for either work or further study. Cairns (2002, p. 6), in a discussion on the various initiatives undertaken to support vocational students in schools, such as Local Learning and Employment Networks (LLEN), notes that teachers were criticized for '…being successful at the university entrance and completion 'game' and thus advising students that it was the main game.' This inevitably leads to the classification of vocational students as rejects or failures both by themselves and their peers, although it would be more correct to say that the system failed to meet the needs of these students, (Cairns, 2002). The Cairns report also notes that initiatives such as the LLEN were moderately successful in rural areas and were favourably received by the students.

Positioning Theory, largely developed by Harré, (Harré and van Langenhove, 1991), suggests that the ways in which people position themselves and others in conversations are largely derived from cultural constructs and this may have a general application within the culture of a school. Positioning theory

combines elements of Vygotsky's cultural/social ideas of child thought development, (Vygotsky, 1962), and also those of Bakhtin, (1981); Howie and Peters, (1996), and Wittgenstein, (1974). Positioning, according to Harré and van Langengrove, (1991), involves the establishment of a hierarchy or power structure, which may occur between individuals or groups. If an individual or group resists the position assigned to them by the dominant person or group then they may obtain by negotiation a difference in their position. Secondary education, and indirectly, primary education is geared towards preparing students for university entrance, (Independent Education Union of Australia [IEUA], 2003). (Cairns, 2002) noted that, this means that students who do not go to university may develop a negative position with regard to their abilities and possibly to some subjects perceived as being difficult or suitable only for those who are going to go to university and that this attitude may be present in teachers as well as in students.

Motivation and Relevance

An important area to consider in relation to the current study is motivation. Maslow, (1943) published what he described as a 'Hierarchy of Needs'. While Freud and many early psychologists developed their theories from studies of neurotic or even mentally ill patients, Maslow based his work on people he saw as having achieved their growth potential. According to Maslow's theory people are driven or motivated by a hierarchy of needs. He outlined five sets of needs which are generally represented as a pyramid with the most basic needs at the bottom.

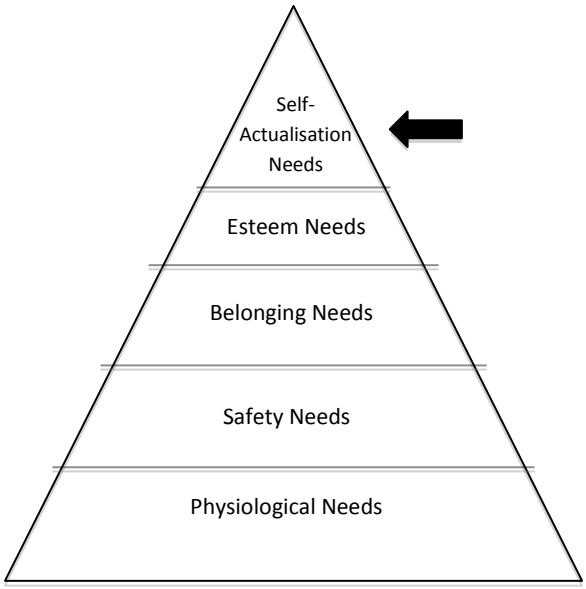
Maslow's idea was that the needs at each level had to be met before the individual could move to the next level. The four sets of needs at the base of the pyramid, Maslow saw as deficiency needs – that is, they are needs which are required to be met before the individual can successfully develop their potential. The highest level of the pyramid, Maslow described as a growth need – that is, the possibility for expansion enabling further individual growth.

The first four levels are:

- Physiological needs: hunger, thirst, shelter, sleep, bodily comfort
- Safety/security needs: out of danger physically, financially and health wise
- Belonging or social needs: friendship, group acceptance by others, supportive family
- Esteem needs: need to be respected and valued by others and for self esteem and self respect with a sense of contribution

The final or self actualisation need is the motivation to for an individual to realise their maximum potential, which Maslow saw as a growth need

Figure 2: Maslow's Hierarchy of needs



While there have been various modifications proposed and while Maslow himself developed sub - categories for the self actualisation need, his theory is well accepted. It certainly gives some pointers as to how lack of confidence can develop. Applied to school children, it is obvious that children will not work well or efficiently if their basic physiological needs are not met. It is also recognised that children need to feel safe within the school environment and while this aspect is more often applied to instances of bullying, it is also relevant where a teacher uses behaviour which is perceived by their students to be intimidatory. The belonging need is also well recognised in the necessity for children to feel they belong in a group for optimal progress. The child who does not have safety or belonging needs met will be reluctant to come to school. For development of confidence and motivation to move further, the child also needs to feel valued and respected, both by their peers and by their teachers. Importantly in the context of development they also need to value themselves and see themselves as worthwhile and able before they can move to the next stage of developing their potential. These areas have been embodied in the Principles of Learning and Teaching [PoLT] which are discussed in detail on pages 30 and 31. These principles arose in response to a Victorian government initiative on teaching in the middle years of schooling.

An important aspect of motivation is that students can see the relevance of what they are studying to their own interests and futures. Carter and Smith, (1998) surveyed high school students' attitudes to science as part of a project to re-conceptualise science for schools, and showed that most students could see little relevance to science. An Australian study of students' motivation and learning was carried out in Queensland by Ng, (1998). Ng used reflective student diaries in a six week study of thirty four high achieving mathematics students. Ng showed that the three most motivating factors for these students were: mastery, goal/task value and a mastery-oriented learning climate. This suggests that to be motivated to study a topic, a student needs to not only be able to see its relevance, but also to feel that it is within their abilities. This correlates with the work of Eccles and Wigfield, (2002) that looked at different motivational theories in terms of three questions that a child might pose for themselves. These questions relate to whether the child can do the task, whether they want to do the task and what they

will need to do to complete the task. They showed that when a child can answer these questions affirmatively, they are generally motivated to complete the task successfully and may then select more challenging tasks.

Research by Kindermann, (2007) demonstrated that students within particular friendship groups share similar levels of engagement and motivation and this is linked to performance. Garner, Bootcheck, Lorr and Rauch, (2006), also suggested that peer relationships are an important part of the social context in learning.

Science anxiety

As previously described, (p. 13), 'science anxiety' is a term coined by Mallow, (1978), to describe the phenomenon of a person experiencing extreme anxiety and a fear of failure when required to do science in any form. As stated earlier, Mallow's later research (Mallow, 1994) suggests that there is unlikely to be any sort of innate problem for females in studying science, although there may be a culturally derived notion that females are less capable of doing science than males. Mallow noted that a majority of clients presenting at his clinic for science anxiety were female and suggested that the lower levels of male students presenting with the condition may be culturally derived in the sense that it may not be acceptable for a male to admit to it. Buckley (2008) suggested that peer culture within a classroom has an influence on both motivation and anxiety. Buckley analysed questionnaires on anxiety, motivation and social network from two hundred and twenty three Year 8 mathematics students from two Australian schools. She noted that the peer influences were complex but linked early adolescence with an increase in mathematics anxiety and a drop in motivation. Ashcraft and Ridley, (2005), linked mathematics anxiety to poor performance and avoidant behaviour. Mallow and Greenburg, (1982) have shown that a high level of science anxiety impedes learning. Mallow, (1986) notes that students' career choices are often determined by how they feel about particular subjects. Mallow also states that science anxiety can prevent students from careers in areas where they fear studying the necessary science courses. Beyer, (1991) following studies on Danish high school students found that science anxiety produced obstacles particularly for both science and humanities particularly to female students. Mathematics anxiety was found to be contagious within friendship groups by Pattison, (1994). Udo, Ramsey and Mallow, (2004) state that there are many causes of science anxiety and that these include poor previous experiences in science classes, lack of role models and stereotyping of scientists in the media. They also suggest that science anxious teachers who may be teaching science in primary and secondary schools may transmit anxiety to their students or convey the idea that science is very difficult.

Gender influences

A number of reports indicate that gender may have an influence on science learning, particularly in relation to girls' exposure to science. The Trends in International Mathematics and Science Study [TIMSS], reports (2003, 2007) noted that the attitudes of girls towards science and access to science subjects was more limited than that of boys, although, other factors such as level of parent education, might outweigh these differences. There are likely to be more subtle influences from gender; for example, a number of studies (Sadker and Sadker, 1985; Irvine, 1991; Jackson and Costa, 1974) have shown that teachers devote more of their attention to male students in a class than to female students.

Irvine, (1991) also noted that this particularly applied to white males. Linn and Hyde, (1989) found that even though middle school students think boys are better at mathematics and science, this is not true. In fact, the main difference between the sexes lies in the confidence level of the student. Linn and Hyde were examining the roots of gender differences in learning. Their work is also supported by that of Fouad and Smith, (1996) whose research demonstrated that at primary school level, girls are more interested in science than boys. Research by Smith, (1992) and also by Paulsen and Johnson, (1983), indicates that girls in the upper primary levels obtain higher marks in science than boys at this level.

As mentioned previously, (p. 27), Mallow, (1994), while researching science anxiety, noted that two thirds of the clients in his science anxiety clinic were female. Alvaro, (1978), developed a scale for measuring science anxiety and using this instrument, Mallow then conducted research comparing Danish and American students. This study showed that in both national groups, a higher proportion of females than males demonstrated science anxiety. However it was noted that Danish females had a lower anxiety rating than American males and that the Danish students generally exhibited lower levels of anxiety than the American students and it was concluded that females did not have an innate science anxiety. This work strongly suggests that perceived gender differences relating to science ability are culturally derived. Perceptions of the inappropriateness of the science field to females, may lead women to have negative views about their ability to succeed in science and hence to develop anxiety about this when they are required to study science. Moreover, there may be teachers who also hold this view. Chiarelott and Czerniak, (1985), working in this area, found that science anxiety starts early on in primary science study, so clearly there are also other factors involved.

A group of researchers at Southern Cross University, (Cullen, Harriott, Knox, Whelan, Saenger and Brooks, 1996) have looked at the influence of gender and age at entry on performance of students in a variety of science subjects and in a third year self-directed learning project. The most significant factor was age at entry, with mature students consistently outperforming younger students. Gender was shown to be significant in three subjects with females doing better than males in both Marine Biology and Land Use Planning. Males performed significantly better than females in Chemistry although this result was hard to interpret as most males entering Chemistry had higher VCE scores than females. Where females had higher entry scores, they did better than males. No significant difference was observed in the third year learning project, suggesting that gender differences cease to be relevant in later years of study.

Teacher issues: The language of instruction

Edwards and Mercer, (1987) have shown that during approximately two thirds of classroom time someone is talking and mostly this is the teacher. Edwards and Mercer's study was carried out across all disciplines, and they also showed that most teacher talk was either lecturing or asking questions. For non-auditory learners, this could impose considerable difficulty in assimilation and understanding of the material. Sutton, (1998) notes that although science is generally seen as a practical subject, the explanations and teaching surrounding this is a discourse. This means that in order to achieve success in science, a high level of literacy is necessary. Some students may lack this background and hence find themselves struggling without understanding why. In this context, Oyoo, (2005), examined the impact that the 'language' of instruction used by school science teachers had on student learning and retention of scientific concepts. He found that most teachers are unaware of difficulties that some students may

experience with their non-technical language. As Oyoo points out, generally, the teacher will make an effort to define and explain technical words, but will seldom be aware of the 'language' in which he/she does so.

One very significant area is the qualifications of secondary science teachers in Australia which in turn can influence teacher behaviour patterns as described by Smith (1990). A study carried out by the Centre for the Study of Higher Education at the University of Melbourne (Harris, Jensz and Baldwin, 2005), showed that 45% of responding schools in the government sector had difficulty retaining science teachers. This contrasted with Catholic and Independent schools in which the percentage was less than 15%. Of the responding science teachers in the Melbourne University study, 53% overall indicated that they would not be staying in teaching. This indicates a high level of dissatisfaction with the profession of secondary science teaching. Of the responding teachers, 71.9% had a science-related tertiary qualification (this included areas such as engineering and agriculture).Of the remainder, 24.6% had an education-based tertiary qualification, while 2.3 % had an Undergraduate Diploma (Science) and 1.3% had other qualifications. These figures suggest that many science teachers are inadequately qualified in either the science or education aspect. Koehler and Grouws, (1992) noted that teachers' behaviour is influenced by their content knowledge, their knowledge/understanding of pedagogy and their knowledge of teaching methods specific to their subject.

Sean-Smith, Banilower, McMahon and Weiss, (2001) have published a report of The National Science Survey of Science and Mathematics Education Trends from 1977 to 2000. This is an American survey but is relevant to Australia as similar trends are shown here. This report examined the perceptions of elementary teachers of their preparedness to teach a range of different subjects. While 76% of them felt prepared to teach Reading, Languages and Arts, only 18% felt qualified to teach Physical Science. The survey covered more than 5000 teachers. In America, as here, there are few specialist teachers at elementary level with most teachers taking a specific grade of students for a range of subjects. Sean-Smith et al, (2001) also carried out a similar survey for high and middle school Science and Mathematics teachers. While 90% of Chemistry teachers felt prepared to teach their subject, only 64% of General Science felt qualified and 66% felt prepared to teach Physical Science. While 94% of Mathematics teachers felt prepared to teach pre-algebra, only 24% felt qualified to teach calculus.

Cultural influences

Cultural background may well be relevant, (Marks, Fleming, Long and McMillan, 2000). Marks et al examined the effect of ethnicity and language background on school performance and likelihood of proceeding to tertiary studies. They showed that while children from some cultural minorities in Australia did less well at school and were less likely to proceed to university, overall, language background had no significant effect. Athanasou and Cooksey, (1994) surveyed high school students, looking at the effect of various demographic factors on students' estimations of vocational interests, and showed that context and cultural background were important influences on their choices although none of the participants identified their background as an influence on the development of their attitude towards science. Comber, (1997) warns against 'labelling' students as this can affect the ways in which they are treated.

Government initiatives on science education

There has been a progressive decline in the number of students completing science subjects in high school since 1970, (Brennan, 1994; Dekkers and De Laeter, 2001). This is in spite of guidelines being in place for the optimal teaching of science and goals for student outcomes since 1979. There are many factors involved in this decline and it has also been experienced in both the USA and the UK. A policy document (Unlocking our Future: Towards a New National Science Policy, 1998) was released by the United States Congress with the aim of reversing or at least halting this decline. It led to the 'No Child Left Behind' policy in the United States and the National Science Education Acts of 2000. The Australian government has also initiated research into the Status and Quality of Teaching and Learning Science in Australian Schools (SIS), Tytler, 2007, 2009 and Tytler, Waldrop and Griffiths, 2004. They devised a set of guidelines based on constructivist lines for the teaching of science.

The SIS guidelines are summarised below:

- Students are encouraged to actively engage with ideas and evidence
- Students are challenged to develop meaningful understandings
- Science is linked with students' lives and interests
- Students' individual learning needs and preferences are catered for
- Assessment is embedded within the science learning strategy
- The nature of science is represented in all its different aspects.

Similarly, the American government established a set of National Science Education Standards (1996, p.28) which embodied five basic assumptions:

- The vision of science education described by the standards requires changes throughout the entire system
- What students learn is greatly influenced by how they are taught
- The actions of teachers are deeply influenced by their perceptions of science as an enterprise and as a subject to be taught and learned
- Student understanding is actively constructed through individual and social processes
- Actions of teachers are deeply influenced by their understanding of and relationships with students

In Victoria the SIS principles led to the Middle Years Pedagogy Research and Design Initiative [MYPRAD] which was another program set up by the Department of Education, and Training [DET] and undertaken by the Centre for Applied Educational Research at the University of Melbourne. It initially involved twelve schools in 1998 and was expanded to 62 clusters of schools by 2000. The aim of the project was initially to collect data on cognitive and affective dimensions of schooling in the middle years; that is from Years 5 to 8. The ultimate aim was to develop a whole school approach to teaching these middle year students leading to an improvement in their learning outcomes, attitudes and behaviour. The

project was completed in 2001. More recently, (2003), materials were developed to enable teachers to better reflect on their teaching and to develop learning teams with a whole school approach. Ultimately, the MYPRAD initiative led to the development of a set of Principles of Learning and Teaching [PoLT]. PoLT was derived with the aim of enabling teachers to work with what was powerful to learn (defined as the Victorian Essential Learning Standards [VELS]), and then to define the principles which promote this powerful learning. This program was expected to be in place in half of all government schools by the end of 2008. The six PoLT principles were designed to be applied across the board in all subjects and grades from Preparatory grade to Year 10. The PoLT principles are listed below:

- The learning environment is supportive and productive
- The learning environment promotes independence, interdependence and self-motivation
- Students' needs, backgrounds, perspectives and interests are reflected in the learning program
- Students are challenged and supported to develop deep levels of thinking and application
- Assessment practices are an integral part of teaching and learning
- Learning connects strongly with communities and practice beyond the classroom

The Victorian Government established an inquiry into the promotion of mathematics and science education. The report titled: Inquiry into the promotion of mathematics and science education, was tabled in the Victorian Parliament in 2006. The chairman of the committee which conducted the inquiry (Steve Herbert, MP), in his foreword to this report, stated: (p. v) 'the economic prosperity of Australia is highly dependent on our ability to develop scientists who can compete globally. Of equal importance is the need for Victorians to be mathematically and scientifically literate, to help empower us as citizens and skilled participants in a world increasingly dominated by technology'. He also noted that one finding of the report was 'the considerable variability throughout mathematics and science education.' (Page V). He also commented on the variability of teacher quality and resources. So, there is government recognition that there are inadequacies in the teaching of science from early primary grades right through to Year 12 level. One of the significant inputs into this inquiry was from the Science Teachers Association of Victoria [STAV], (2006). STAV looked at a number of areas ranging from facilities and resources to the adequacy of primary teacher training for science and maths and also professional recognition, status and self -esteem. Among the recommendations of their final report was:

- Recognition of the variability of both level of priority given to science in the primary school and in the primary teacher's conceptual understanding of maths and science disciplines.
- The need to increase the level of engagement of early secondary students with mathematics and science.
- Ensuring the relevance of these disciplines in future work applications (as seen by the student).
- Ways of dealing with the shortage of highly qualified teachers in these areas.

Summary

This synthesis of the research literature reports on a number of issues relevant to the research questions. These issues include the various learning theories, the phenomenon of science anxiety,

motivation and student attitudes, school sub-cultures, gender issues and government initiatives and policies.

Chapter 3, which follows details the research design and the methodology used to collect the data and extract themes from it.

CHAPTER 3: METHODOLOGY

Introduction

This study set out to examine the influences that are important in developing interest in science and confidence in the ability to succeed in science studies. It is an ethnographic study of a group of TAFE students most of whom display a lack of confidence and anxiety about their ability to succeed in the science units of their current course. This is despite the fact that they have successfully passed science subjects in secondary school. Moreover they continue to lack confidence in their science ability even after passing their TAFE science subjects. Wolcott, (1997), states that ethnography is a picture of the way of life of some identifiable group of people. What was desired in the current study was an aspect of the culture of the group of TAFE students studied which related to their science experiences both at home and at school. This ethnographic approach aimed to understand which of these experiences were important in developing the lack of confidence in science ability displayed by this group. Organizational culture is a concept which can be used to differentiate between groups within a society (Pettigrew, 1979). Morgan, (1986) refers to the development of an organization's culture reflecting its daily rituals and ideology among other areas. Study of an organization's culture can be used to change an organization's culture (Schein, 1985). So what was sought in this particular research were the types of science experiences undergone by the group of TAFE students in the study, and which of these experiences were common to the group as a whole with the ultimate aim of identifying ways to minimise adverse influences in the future. The research questions, listed below, delineate the boundaries and framework of the research. The participants and their backgrounds are outlined together with the mode of selection. The detailed methodology used for data collection is then discussed. This is followed by an analysis of possible biases in the research and the extent to which these were minimised. The next section details the method of theme extraction and the ways in which the themes were grouped. Finally the methods used to validate the study are described.

The research questions

The project arose as a result of observations made by the researcher while teaching science to Beauty Therapy students at Victoria University. These observations were that Beauty Therapy students displayed very low confidence in their ability to succeed in the science units of their courses and expressed anxiety about passing their course as a consequence. In some cases, the anxiety level was very high. This was despite the fact that ultimately they not only passed their examinations but did exceedingly well. The researcher became interested in the underlying causes of the low level of confidence displayed by these Beauty Therapy students and developed the research project to investigate this.

The research questions were:

1. What experiences in learning have contributed to the development of poor confidence in the ability to do science and to low levels of scientific literacy in a group of Beauty Therapy students?
2. What other experiences may have contributed to the low levels of scientific awareness and confidence displayed by these Beauty Therapy students?
3. Which of these factors are common to the group as a whole?

Framework and boundaries of the study

The framework for the research was determined by the research questions which specifically set out to examine the science experiences of a group of Beauty Therapy students, with the aim of finding factors which contributed to low levels of confidence in science ability. It was decided that interviews were the best technique for obtaining this information. The population from which the participants for interview were drawn was the group of students studying Beauty Therapy at Victoria University between 2006 and 2009. All classes of students studying Beauty Therapy at Victoria University during this time were visited and the purpose of the proposed research was explained verbally and a written handout detailing the research project was distributed. (See Appendix I, Information to Participants). Participants were then selected by asking for volunteers for interview from the different Beauty Therapy classes. This is an application of the sampling technique described by Goetz and Lecompte, (1984), as quota selection, that is, a group of participants were taken from the population under study. The sampling was also driven by the research questions where the aim was to get a view from different instances of the development of attitudes towards science. This is described by Glaser and Strauss, (1967), as theoretical sampling.

The participants were self-selected from the group of Beauty Therapy students. It was open to any of these students to volunteer for interview and no volunteers were refused. The assumption was made that the volunteers were a representative sample of the group of Beauty Therapy students, although it is recognised that there is a possible bias in whether the students who volunteered for interview were in some way different to those who did not. This is discussed in greater detail in the section on possible biases.

Initial questioning at interview established that all participants had their school education in Victoria except for two participants who each spent a year at a religious school in Turkey. Therefore a further assumption was made that the participants were a sample of past Victorian school children. The sample size was small - hence no quantitative inferences are drawn from the data.

The information sought from the interviews was limited by the probes used during the interview and also by time limitations. Initially, a list was made of those areas that the researcher thought would be relevant and the probes were designed to guide participants into these areas. When asking for volunteers, the researcher stated that the time involved would be approximately one hour.

The study design

As can be seen, the aim of this study was to obtain a picture of the sorts of experiences which have influenced the ways in which the participants developed their attitude towards science and their perceptions of science generally. Clearly this would be different for each individual involved, but the intention was also to identify any common factors within the group. School science lessons obviously play an important part in developing these attitudes and perceptions and the researcher had expected to find strong influences from other areas such as cultural background, gender and position in the family.

The following methods to collect data were considered:

- A fixed questionnaire for large numbers of students
- An interview with closed questions
- A semi structured interview with open–ended probes

The advantages and disadvantages of each of these options were then considered. The fixed questionnaire was undoubtedly the simplest option, (Neumann, 2003; Smith and Glass, 1987). However, it was felt by the researcher that it would be difficult to set up a questionnaire which would elicit the appropriate information and which would not tend to direct the answers down particular paths. Secondly this type of approach needs a large number of participants to obtain validity from statistical analysis. Both time constraints and the number of participants available made this approach impractical.

On consideration, it was decided that the best method of eliciting the information required was by interview. Dexter, (1970), defined an interview as a purposeful conversation, while Merriam, (1998, p. 72), stated that '…interviewing is necessary when we are interested in past events or in how people interpret the world around them.' What was desired in the current study was to elicit the participants' past experiences in science and how they interpreted them. In other words, it was desired to obtain their individual science 'stories'. The next consideration was to determine the type of interview that would do this most successfully.

The fully structured interview was considered. This is as an interview where all participants are asked to respond to the same set of questions or stimuli, (Bernard, 1988). The questions used are usually closed or have simple answers. It has the advantage of tightly delineating areas covered and consistency from one interview to the next. However the researcher decided that a fully structured interview would not elicit information from the participants in an experiential form and moreover could to some extent lead their responses, (Gendal, Menelau and Brennan, 1996). The use of open-ended questions in interviews is recommended by Brenner, Brown and Canter, (1985), and also by Rubin and Rubin, (1995). Hence the questions needed to be open-ended, so that the participants were free to follow any path that they opened up. Denzin, (1970) has also pointed out that a structured interview assumes that the meanings of the questions are the same for every participant which may not be so. This particularly applies in the current study where, although the participants all spoke English at home, and with two exceptions were born in Australia, their parents came from several different cultural backgrounds.

The semi structured interview works from a guide or list of areas to probe, (Bernard, 1988), enabling the interview guide to be worked out beforehand ensuring consistency between interviews but because probes and questions are open-ended, it allows for emergent themes to be further explored with the participant. The semi structured interview gives both the interviewer and the respondent the freedom to clarify and negotiate the meanings of both probes and responses to reach a position of mutual understanding. Hence the best option was the semi-structured interview and this was the approach adopted.

Opdenakker, (2006) compared four different types of qualitative research interview and identified the advantages and disadvantages of each. One of the main advantages Opdenakker listed for the semi structured interview was that it is face to face which gives it time synchronicity between the questions and the answers. This is likely to lead to more spontaneous answers. It also gives the interviewer the opportunity to pick up non-verbal clues displayed by the participant. Many of the participants in the current research appeared to be disappointed by their school science as they had anticipated more from it. Some participants had experiences in their school science classes which had been distressing for them and this was apparent during the interview.

Kvale, (1983, p. 174) gave a definition of a research interview as: '…an interview, whose purpose is to gather descriptions of the life world of the interviewee…' and this was precisely the intention of the current study. It is the particular life experiences in science that have shaped the participants' attitudes

towards and perceptions of science that is of interest. Erickson, (1987) suggested that this type of study does not lead to abstract knowledge in the way that a study involving significant statistics from a large sample does. Rather from the detailed interpretation and comparison of cases, it is possible to obtain a concrete and general statement which may be applicable to other similar cases. The ultimate intention of this particular study, as discussed later in this chapter, is to gain some understanding of the sorts of influences which shape the ways in which children develop their perceptions of science. This enables adverse influences to be minimized in the future.

There was a certain amount of background information needed, and this was obtained by asking participants to fill out a Questionnaire to Record Personal Details (Appendix III). This written component contained details such as age range, cultural background, home language, number of siblings and position in family in addition to contact details.

Each interview lasted for approximately fifty minutes and was preceded by some time spent gathering background information and ensuring that the participant was comfortable. The interviews were recorded with an audio taping device. The audiotapes were then transcribed verbatim into a computer and analysed for themes. The themes extracted were further analysed to find themes which were common to a number of the participants. This process is detailed in the section on Data Analysis later in this chapter

As described earlier, selection of participants was entirely voluntary on the part of the participant. A group of students was selected from the Beauty Therapy classes by asking for volunteers after explaining the purpose of the research. It was emphasised to these students that as participants, they would have the opportunity to withdraw their data at any stage without incurring any penalty. In the case of withdrawal, the participant would have their transcript returned to them.

The students were informed that there would be no academic advantage or penalty to them for participation or non-participation and that complete confidentiality would be maintained. As the researcher is no longer teaching in Beauty Therapy, she was not previously known to any of the participants and had no potential for input into their study outcomes. Each participant was required to sign a written Consent Form for Subjects Involved in Research (Appendix II), which outlined the conditions of use of the material gathered and certified that any such material would be confidential. It was stressed that pseudonyms would be used in any publicized data and that identifying characteristics would be kept in a secure place. All interviews were held in a classroom at the King St City Campus of Victoria University. This venue was selected as it was one with which the participants were familiar and it was possible to organize the interviews between classes for the participants which involved them in minimal extra time and inconvenience. All interviews were conducted by the researcher in order to maintain consistency.

The sample size was small - hence no quantitative inferences are drawn from the data. Quantitative data usually involves numerical measurement of particular variables with as many other variables as possible controlled (McDonald, 2009). The only numerical measurements taken from the current study were the numbers of participants demonstrating a particular theme. The total number of participants was too small to use these numbers in any statistical analysis.

Interview procedure

Before the start of each interview, the researcher explained a little about herself, and the purpose of the research and what she hoped to achieve. The participant was then asked to fill out an Informed Consent Form for Subjects Involved in Research (Appendix II), and a Questionnaire to Record Personal Details (Appendix III), in order to obtain necessary background information, and it was explained why this information was important. Each participant either chose a pseudonym or was assigned one to ensure confidentiality. All participants were told that participants had the opportunity to withdraw their data at any stage without incurring any penalty. In the case of withdrawal, the participants would have their transcripts returned to them. The interviews were then able to proceed in a comfortable and relaxed manner.

As stated on the previous page, all interviews were conducted in a classroom at the King St City Campus of Victoria University which was a venue familiar to the participants as it was where they had their Beauty Therapy classes. The interviews were tape-recorded and the transcripts were subsequently typed verbatim into a computer for analysis. All tapes and transcripts are kept in a secure place accessible only by the researcher. To ensure consistency, all interviews were conducted by the researcher.

Each participant was asked at the start of the interview to rate their ability to successfully pass their current Technical and Further Education (TAFE) science courses on a scale of one to ten. Those participants who rated themselves as lower than five out of ten and who expressed anxiety about passing their current courses were classed as low in scientific confidence.

Following this, a series of semi-structured probes and open–ended questions were posed to each participant to elicit the story of their science experiences (See Appendix IV: Probes Used in Interviews). The questions used were developed after consultation with the researcher's supervisor, (Associate Professor Bill Eckersley) and a number of other colleagues.

Siedman, (1991) proposes that successful interviews require the interviewer to have sufficient distance to enable them to probe issues that arise, but also to be conscious of the relationship between the interviewer and the participant. There is both a power issue and also one of difference in that the interviewer comes from a different group. The researcher was aware of both the power issue and the possibility of leading the participant and endeavoured to remain unobtrusive and to allow the participants to recount their own experiences without imposing any influence on them.

As stated previously, at the start of each interview, participants were asked to rate their ability to do science. This was done to gain a feeling for their confidence in their ability to do science. From that point onwards, the probes listed in Appendix IV were used. In some instances, to encourage further discussion or to maintain rapport, something of the researcher's own background and experiences was inserted. Initially, the participants were probed about the way they felt about science and scientists, and then their earliest memories of science. The researcher was interested in identifying firstly whether the participant had ever enjoyed science and if so, the point at which their attitude changed.

The participants were also asked how they saw themselves in relation to science. They were then asked to describe their school science experience. In addition to their educational experience in science, other factors such as influence of gender, attitudes of family and mentors were explored. The researcher had expected peer group pressure to be important but the participants were all adamant that this was not important to them although this probe elicited awareness of 'cool' groups, 'nerds' and so forth within the school culture.

Another aspect which was explored was the general school experience of the participant. This was done to see if the respondent appeared to have problems generally or just in science. Participants were then asked about any other influences that had affected their attitude to science. They were also probed about the science in their current Beauty Therapy courses. This area was probed to gain an understanding of how their attitude towards science had affected their subsequent lives. They were also asked about influences on their career choices and their preferred learning styles although these were not formally assessed in any way. The aim here was to see if the ways in which they had been taught science were incompatible with their preferred learning style.

The researcher endeavoured to follow through with the probes in the same way for each participant. However, as some participants identified particular pathways these were followed in preference to the probes although the interview was subsequently brought back to these other areas, so that all participants responded to all probes. The interviews yielded some very rich data of individual case studies which are examined in detail in Chapters 4 and 5. They have also enabled clear identification of factors which are common to most participants and which are clearly causal in the development of the participants' attitudes towards science. A number of peripheral issues were also exposed.

Possible biases

This section covers areas of possible bias in the research findings. These issues include researcher bias, reporting bias and volunteer bias.

Researcher bias

In reference to interviewing in qualitative research Lave in an interview by Kvale; (Lave and Kvale, 1995, p. 220) stated that: 'the only instrument that is sufficiently complex to comprehend and learn about human existence is another human'. This statement supports the value of interviews as an effective research tool. However, the researcher's own beliefs and prejudices are influential in the way in which the interview is conducted, (Ross and Lepper, 1980). Ross and Lepper reviewed the fact that people tend to cling to their beliefs even in the face of strong evidence to the contrary. McEwan and Bull, (1991) give several examples of famous scientists who have clung to a particular belief or theory even when there is evidence against it. Any qualitative research has to involve a level of understanding by the researcher of what the participant is saying and this is always going to be coloured by the researcher's own beliefs and prejudices. This means there will always be a level of uncertainty about the interpretation of the data. The researcher endeavoured to look at her beliefs prior to the study and ensured that the probes and questions used were not worded in a way to lead participants.

There is also a power issue involved in interviewing because the researcher has control over the interview, (Burmann, 1997). Brinkman and Kvale, (2005), in a paper on the ethics of qualitative research, discuss the relationship that develops between the interviewer and the participant. The researcher also did her best to ensure that any nervousness or anxiety on the part of the participant was reduced by conducting the interview in a familiar and safe environment. The researcher tried to ensure that her intrusion into the interviews was minimal so that the participants felt free to speak.

Brinkman and Kvale, (2005) note that when a participant is invited by the researcher to become part of the research process, this creates a powerful relationship between the researcher and the participant. This was reduced as far as possible in the current study by ensuring that all participants understood what

the study was about and what was expected of them. In addition, as far as the researcher was able, the interviews were consistent and the same areas explored with all participants.

Reporting bias

Researcher bias can take several forms, (Bogden and Biklen, 1992; Miles and Huberman, 1994; Rosenthal, 1976). These stem from the effect of the researcher on the site of research and the effect of the site on the researcher. It also occurs if the researcher's bias influences the selection of themes from the data, (Wolcott, 1982). Wolcott (p.157) notes that 'it is impossible to embark upon research without some idea of what one is looking for and foolish not to make that quest explicit'; so that themes which correspond to the researcher's ideas of possible causes of an effect may be the ones noted at the possible expense of other data. Of relevance here is the fact that in the current study, the results were not what the researcher had anticipated.

The researcher was aware of possible biases in her reporting. All interviews were tape recorded and the exact transcripts typed from the tapes including pauses and 'ums and ers'. In the analysis of the study, each theme was illustrated with examples in the participants' own words taken directly from the transcripts. This was done to minimize bias in the reporting.

Moreover the data was collected in a face to face situation in real time, where the reactions of participants could be noted in addition to their responses. It was apparent in some of these cases that there was considerable emotional involvement in their experiences. The emotions most commonly observed by the researcher were regret, disappointment and relief to have told someone their experiences or possibly simply that someone had an interest in them. What the researcher was seeking was descriptions of actions and reactions by and to the participants in order to gain an understanding of how these events influenced the development of particular attitudes of the participants. The face to face type of interview was a better way to obtain this information. The focus of the interviews was on actual real life experiences of the participants not on hearsay or reports of situations. It was endeavoured to report these as accurately as possible.

Volunteer bias

As has already been noted, there is a possible bias in the fact that those students who volunteered for interview may be in some way different to those who did not. Krishna, Maithreyi and Surapaneni, (2010, p. 2322) in an article on research bias stated:

'Volunteer or referral bias occurs because people who volunteer to participate in a study (or who are referred to it) are often different than non-volunteers/non-referrals.'

They further noted that volunteers tended to be more highly motivated than non-volunteers. However Krishna et al were reporting on people who volunteered for medical studies which is a different type of population from the one in the current study. Fowler, (1984) suggested in reference to mail-in surveys that those people who responded may have more interest in the topic of investigation than those who did not return their survey form. The researcher visited all of the Certificate II and III Beauty Therapy groups to explain the project and ask for volunteers. As any of the Beauty Therapy students in these groups were free to volunteer for participation in the research project and all volunteers were interviewed, there was no bias from the researcher in the selection of participants.

Of relevance here is the fact that when requesting volunteers for interview, many other students stated that they would like to participate but work or family commitments made it difficult or impossible for

them to participate. Another point is that the researcher taught Beauty Therapy students for eight years and she felt that the group of students who volunteered to participate in the study was representative of the population of Beauty Therapy students. This is a subjective judgement, so the possibility of volunteer bias is noted.

Other possible influences

Goffman, (1959) describes the effects on a population of a researcher being present from the point of view of a member of that population. That is, there is a need to understand why the researcher is there, what threat exists with the collection of information and what might that information be used for. Moreover, participants may put on a specific presentation for the researcher. In the current study, the researcher having taught Beauty Therapy students for eight years was very familiar with the characteristics of this particular population and also with the area in which the interviews were carried out. This enabled her to approach the various Beauty Therapy classes in a minimally intrusive way. In addition, great care was taken in explaining the purposes behind the research and the reasons for undertaking it. It was also explained in detail how the information would be used and how confidentiality would be maintained. Selection of a venue for interviews was carefully thought out in ensuring privacy and freedom from interruption together with minimal disruption for the participants. The topic under research appeared to be one that the participants were pleased to have the opportunity to talk about (subjective view of the researcher).

Another possible aspect of bias is whether the impact of particular incidents in their science classes gave the participants a biased view of their classes as a whole.

Triangulation

Triangulation is a method of validation which involves looking at a situation from several different angles, (Neuman, 2003). There are several different types of triangulation as Neuman describes, but all rely on obtaining different perspectives on the research questions. These can be from published data or research, internal validation from contrasting results in the data, or using several observers in either collecting data or analysing it. The last perspective was not available as there was only one researcher in this study. Internal validation of the data was supplied by comparing experiences from the non-confident group of participants with those of the participants who felt confident about their ability to succeed in their science studies. In addition, the non-confident group reported an increase in confidence after experiencing the different approach used by their teachers in their current TAFE science units. A number of sources in the research literature have reported on the effects of some of the features described by the non-confident group of students, (Lindahl, 2003b; Lyons, 2003; Osborne and Collins, 2001; PISA, 1992, 1997, 2000, 2003, 2006; TIMMS, 2003, 2007; Tytler, 2001, 2007, 2009). Combining this data provides a critical insight into school science education as experienced by a group of Beauty Therapy students at Victoria University.

The backgrounds of the participants

The backgrounds of the fifteen participants are summarised in Table I below. These backgrounds are examined in greater detail in Chapter 4 which is on the Participants and Their Stories.

Table 1: Summary of participants' backgrounds

NAME	GENDER	SCHOOL LEVEL	HOME LANGUAGE	POSITION IN FAMILY	SIBLINGS	AGE RANGE	SELF-EFFICACY RATING (OUT OF 10)	CULTURAL BACKGROUND
Annabelle	F	Year 12	Dutch and English	Youngest	1 brother	20-25	2	Dutch parents but born in Australia
Bertha	F	Year 10	English	Eldest	1 brother	20-25	1	Father Australian Mother Maltese but born in Australia
Constance	F	Year 12	English	Eldest	1 brother	20-25	1	Australian
Daphne	F	Year 10	English	Eldest	2 sisters	25-35	9-10	Parents English but born in Australia
Edward	M	Year 12	English	Eldest	1 brother	20-25	4	Australian
Florence	F	Year 12	English	3rd oldest	1 sister 2 brothers	35-45	10	Hungarian parents Immigrated to Australia when a very young child
Gillian	F	Year 10	English	Youngest	1 brother	45-55	7	Australian Catholic
Harry	M	Year 12	English	Eldest	1 sister 7 years younger	20-25	4	Scottish parents but born in Australia
Kylie	F	Year 12	English	Eldest	1 sister	20-25	4-5	Australian
Lucy	F	Year 11	English	Youngest	1 brother	18-20	3-4	Australian/English but born in England. Migrated with parents as a very small child*
Therese	F	Year 11	English	Oldest	1 sister	18-20	4-5	Italian but born in Australia
Vanessa	F	Year 11	English	Middle	Older brother, younger sister	18-20	4	Australian
Xandra	F	Year 12	Turkish and English	Youngest	2 older sisters	20-25	4-5	Turkish parents but born in Australia
Yvonne	F	Year 12	Turkish and English	Youngest	1 brother and 1 sister	25-35	2-3	Turkish parents but born in Australia. Muslim religion
Zara	F	Year 12	English	4th daughter	3 older sisters, 1 younger brother	18-20	2	Egyptian parents but born in Australia

Data Analysis

Data reduction is described by Miles and Huberman (1994, p.11), as '…a form of analysis that sharpens, sorts, focuses, discards, and organizes data in such a way that "final" conclusions can be drawn and verified.' Wolcott (1994) describes data reduction in terms of three processes. Firstly a descriptive phase which is usually in the form of field notes or transcripts of participants' own words. This is followed by a systematic analysis which identifies major themes and finally, interpretation of the meaning. Data reduction involves selection of salient themes by the researcher. The researcher is aware that her own beliefs and experiences can affect the selection of material and themes from the data as this is necessarily a subjective process. All themes selected were backed up by statements from the transcripts in the participants' own words.

1. Extraction of themes

The first stage in the analysis of the data involved extracting themes from the transcripts.

Initially brief notes had been made by the researcher following each interview in which the researcher listed the types of events described by the participant and the people involved. This led to the emergence of some preliminary threads. The method of theme extraction was based on that recommended by Dr Anne Davies of Victoria University (personal communication), for case study analysis. It is similar to the coding process described by Agar (1980). In this technique, the transcripts were entered in one paragraph and a simple colour coding system was devised in which identified themes were highlighted in different colours across the transcripts. This led to the development of threads or themes in the stories the participants told. This process is described by Goetz and LeCompte (1981, p. 57) as '…scanning the data for categories of phenomena and for relationships among the categories.' These threads or themes were then sorted and grouped.

2. Grouping the themes

After the themes had been identified, they were sorted into groups or clusters using the method described by Krippendorff (1980a). In this technique, the themes are clustered in broad categories initially and then these categories are further clustered. This process led to the identification of two major categories for the themes which were: teacher-related themes and participant-related themes. As Miles and Huberman (1994) point out, the themes may have several factors which put them in more than one cluster. This means that there is some overlap between the clusters, that is, each cluster is not exclusive of themes in the other clusters. There were further groups and tables established relating participants to the different themes. Finally, the themes were related to each participant's scientific confidence level (self-rated as described above in the section titled 'Interview Procedure'). It was then possible to relate the themes to the ways in which participants had developed their attitudes towards science and their level of confidence to succeed in science studies. These relationships were then linked back to the research questions.

3. Data Display

In the current research, during the data reduction process, the researcher was endeavouring both to determine the impact of the data in the participants' own words which were often very powerful and to

obtain an effective summary displaying the answers to the research questions. To this end, she used a mix of quotations from the interviews and tables or matrices showing salient themes. Drawing conclusions from these was done as a continuous process in that themes were observed and noted throughout the interview process although they were not put together until the interviews were completed. The other aspect continuously explored was ways in which to validate the data collected.

Validation of the Data

Data validation is very important as it determines the likelihood of the findings from the research being authentic (Miles and Huberman, 1994). If the conclusions drawn from the study are valid, then they should also be repeatable by other researchers. Lee (1991), describes validation as linking the understanding and interpretation by the researcher with the intended meaning of the participants. The researcher's conclusions then are drawn from their understandings, so it is important that the first link is valid before the second link can be authentically made. Miles and Huberman (1994, p. 263), state that:

> 'Data quality can be assessed through **checking for representativeness** (1); **checking for researcher effects** (2) on the case and vice versa; and **triangulating** (3) across data sources and methods.'

In the analysis of the data in the current study, the researcher used the participants' own words to illustrate the themes extracted from the data. In most cases, there are quotations from the transcripts of more than one participant together with tables showing the frequency of occurrence of a particular theme among the participants. Where a theme has a high frequency of occurrence, a further link was made indicating that this was an important factor in the formation of attitudes and perceptions towards science. That is, that the data is representative of the sample population of Beauty Therapy students.

Internal Validity

The types of threats that may interfere with internal validity are other variables which may interfere with the results. These include history or previous transfer of expected results to the participants. In the current research, the only preliminary information given to participants was a copy of Appendix I, 'Information for Participants' and this contains nothing about expected results. What was emphasised was that the researcher wished to gather the science stories of the participants whether these were positive or negative. The aim of this was to identify experiences which had an impact on participants' attitudes towards science.

Neuman, (2003), describes experimenter expectancy as a situation where the researcher inadvertently communicates their expectancy of the results to the participants. As the results were not what the researcher had anticipated, this could not have occurred in this case. In addition, the researcher was not previously known to any of the participants and had no prior knowledge of any of them. The only contact was to request volunteers and arrange interview times.

Another possible threat to internal validity can arise from the setting of the interview and care was taken to ensure that this was a familiar environment for the participants. The researcher spent a few minutes at the start of each interview chatting with the participants to ensure they were comfortable with the procedure.

Prior assumptions by the researcher may impact on the research. In this case, the researcher had no prior assumption that school experiences were a cause of lack of confidence in science. Because school science is the major experience of science for most people, it was clearly important to probe this area. However, it was not the only area that was explored. Participants were also questioned about the effects of family influences, gender, cultural background and any other areas that the participant thought was relevant to their experiences of science.

Connelly and Clandinin, (1990), in discussing the validity of narrative research suggest that verisimilitude and apparency are important aspects of interpretation. That is the appearance or perception of the data being real or true is a factor in the interpretation of this type of research.

The extracted themes were compared with the participants' self-rated levels of confidence in science ability. Where there was a high level of linking of a theme with the level of confidence in science ability, the conclusion was drawn that that theme was relevant to the development of confidence in science ability.

Several participants compared the way in which they were taught science in their current Technical and Further Education (TAFE) courses with the way in which they were taught science at school. Some participants used other subjects in which they had done well as a comparison. Some participants had very positive science experiences at school. These comparisons are also described and give the data more authenticity.

External Validity

As another way of validating the material, published surveys and data on science teachers' conditions were explored and demonstrate that many Australian science teachers are operating under considerable difficulties which would inevitably affect their teaching. This gives a validation of the descriptions given by most participants of the limited pedagogies applied by their school science teachers. In turn this enabled some conclusions to be drawn which answer the research questions and also pointed to ways of improving the current situation.

Another aspect of validation is pointed out by Schacter (2001), who has researched the ways in which memory and recall operate. Schacter states that we do not recall events exactly as they happened, but reshape key elements into an experience which we recall. We may also 'sanitise' the memory to show our behaviour in a better light. These aspects all point to the importance of observing common themes in the narratives of the participants.

There is also a large amount of published literature on factors behind the loss of interest in science progressively displayed by secondary students particularly in western countries. (Adams, Doig and Rosier, 1991; Goodrum. Hackling and Rennie, 2001; Haladyna and Shaughnessy, 1982; Lederman, 1992; Speering and Rennie, 2006; Tytler, 2007, 2009). This is discussed in detail in the literature review and shows a strong connection between teacher attitudes and pedagogies and student attitudes towards science.

Summary

This chapter has described the methods employed in the study and discussed the design of the research. The selection of participants and the interview process has been detailed. Extraction and grouping of themes and validation of data has also been discussed together with possible biases. The next chapter

(Chapter 4) details the experiences of each participant and reports the data obtained from the interviews.

CHAPTER 4: THE PARTICIPANTS AND THEIR STORIES

Introduction

This chapter introduces the participants in detail discussing their backgrounds and individual stories. The participants' experiences of science are mostly school experiences. Participants were asked about other influences, but the dominant impact was from their school science. Participants were asked to rate their ability to engage successfully in science learning on a scale of one to ten. What was meant by this was an estimate of their confidence to understand the science that was required of them in their current courses and to succeed in passing the relevant science subjects. Participants were also asked about their feelings towards science and their science courses in their current TAFE courses. At this point, the participants had had several weeks of their current courses and so knew what was involved. Those participants who gave themselves a rating of five or less out of ten for their ability to do science were classed as low in confidence. Many of the participants in this group also expressed anxiety about succeeding in their current science courses Those participants who rated their ability to do science higher than five out of ten and who were confident of passing their current science courses were classed as high in confidence. The group with low confidence levels all described poor experiences of science at school, while the group with high confidence levels all described a relatively enjoyable school science experience.

Introduction to the participants

There were fifteen participants in the study. They comprised 2 males and 13 females. All but two (Lucy and Florence) were born in Australia and they both arrived in Australia at a very young age. All were educated in Australia with the exception of the two participants with Turkish backgrounds (Xandra and Yvonne), who each spent time at a religious boarding school in Turkey. The ages of most participants in the study ranged from eighteen to twenty-five. This means that most of the participants left school within the previous decade to the time at which the interviews were conducted. Their science experiences therefore reflect school science practices which are relatively recent. No participants were from single parent families although Harry has a stepfather who was interested in his progress. In all cases but one (Yvonne), the dominant language spoken at home was English and for three participants, there were two languages – English and Dutch in Annabelle's case and English and Turkish for Xandra and Yvonne. There were two older participants in the study, both female (Florence and Gillian) and their experiences provide an interesting contrast to those of the younger participants. Most of the participants attended government schools aside from three who attended Catholic schools, (Annabelle, Gillian, and Therese) and one, (Edward) who attended a private school. These backgrounds are summarised in Table 1 on page 41. There were no aboriginal participants in the group. All the participants attended urban schools. The participants were asked to rate their ability to pass the science units in their current Beauty Therapy courses on a scale of one to ten. These ratings are also included in Table 1.

The science experiences and stories of the participants

In this research, the researcher investigated the perceptions of a group of Technical and Further Education [TAFE] students with reference to their experiences in and of science. Most of the students in the group expressed a low confidence in their ability to succeed in their current science courses and were experiencing anxiety over their likelihood of passing the required science units in their current course of study. This group also described poor and in some cases unpleasant experiences in science at school. This is in sharp contrast to the few students in the group who expressed higher levels of confidence in their ability to succeed in their science studies. This latter group had had positive and interesting experiences in school science. Interestingly, the two older participants in the study (Florence and Gillian), both expressed a keen interest in science and described their school science experiences as interesting and enjoyable, although somewhat limited. Moreover many of the students in the first group reported an improvement in their confidence levels with the type of science teaching used in their current TAFE courses. The other relevant point is that, in other subjects, including mathematics, where the participants described positive experiences, their confidence levels were high. It is emphasised that the material reported here relates to the participants' perceptions of their experiences.

Annabelle

Annabelle was born in Australia of Dutch parents. She has one older brother and the languages spoken at home are Dutch and English. She is in the age range of 20-25 and completed Year 12 at school.

Annabelle described herself as lazy and non-academic. She stated that although she passed her examinations in science, she did not work at science and so did not do as well as she was capable of doing. However, Annabelle successfully completed the Victorian Certificate of Education including science subjects. Annabelle also stated that she used to really enjoy science until Year 11 when she had a teacher who she perceived as disliking her and marking her unfairly as a consequence. This particular teacher was also very discouraging from Annabelle's perception and actually advised her to go and work in a factory. Moreover when Annabelle asked for a reference, the teacher refused. At this point, Annabelle started playing truant from school, having discovered that nobody noticed if she was not there and none of the teachers asked after her. She said she had a friend at this time, which was a bad influence on her and that it was more fun to socialize than to go to school. Despite this, Annabelle was adamant that if she really wanted to study science, the attitudes of her friends would make no difference and she would still study it. Annabelle's perception of her science teacher was that she just 'wrote her off as nothing much' (Annabelle, Interview, 2006). Annabelle was the only participant who preferred the way science was taught at school to the way it is taught in her current Technical and Further Education course. Her criticisms of her school science related more to Annabelle's perceptions of her science teacher's attitude towards her than of the way the science was taught.

Bertha

Bertha was born in Australia and has an Australian father while her mother is Maltese. The language spoken at home is English and Bertha has a younger brother. She completed Year 12 at school and is in the age range of 20-25

Bertha said she was very keen to learn science at school, but her perception was that the teachers did not make it interesting. She stated that she was not given help to understand it and ascribed her lack of confidence in science to this. Bertha blamed herself for not working properly but also stated that she was not shown how to do it. As an example of this, Bertha described some microscope work where she was unable to see the things she was supposed to see and was unable to get help with using the microscope. She then concluded it was a waste of time. She continued with science until Year 10, but said that it was never made interesting or relevant and that she barely passed.

Her current courses in science have revived her interest, in particular, because she can now see the relevance of it. Bertha gave a good example of the importance of relevance in relation to chicken breasts. She said at school, they were given chicken breasts and just told to find the muscles and tendons, but she did not understand the point of looking at chickens. In her current course when they looked at chicken breasts, the teacher drew pictures and diagrams and explained that the basic structure of the chicken wing is the same as that of the human arm. This made sense to Bertha as she could use chicken breasts as a model for human function. Bertha described her general school experience as good with the exception of science which she used to dread. Bertha felt that she did not understand her school science and was not given help so she 'blocked it out' (Bertha, Interview, 2006). Bertha's explanation of this was that she did not like failing so she just did not try. Bertha could then rationalize a failure as due to not working rather than to a lack of ability. (She did in fact pass).

Bertha also stated that she did well in other subjects including mathematics where she was an A+ student, so her problems with science do not appear to stem from a lack of ability. Bertha described her mathematics teacher as being really good and of helping straight away with any difficulties she had. In reference to her current science courses, Bertha initially was aiming for 50% and to just pass, but now with more confidence and a different teaching method, she is interested and is aiming to do really well. Despite this, Bertha still only rated her chances of passing her current TAFE courses as one out of ten.

Constance

Constance is Australian born of Australian parents. She has one younger brother and completed year 12. The language spoken at home is English. Constance is aged between 20 and 25.

Constance's perceptions of science and science teachers were that they were both 'very frightening' (and she saw this as normal). Her statement about her first science lesson in her current course was that 'obviously', she was terrified, (Constance, Interview, 2006). However, her current teacher realised this and took her aside to reassure her and Constance is now enjoying science. At school, Constance described a rigid science class where questions were discouraged. Students were expected to copy notes from the board and then answer questions in writing. Constance also described her science teacher as using derogatory remarks which Constance found embarrassing and intimidating. Constance stated that she was unable to make sense of her practical classes because they had not done the theory. From her description, there appeared to be little correlation between theory and practical work. Constance expressed fear of her school science teacher while at school and dreaded every science class. She also stated that the girls were made to sit at the back of the class although she did not know why.

Daphne

Daphne was born in Australia of English parents. She has two younger sisters. The language spoken at home is English. Daphne completed Year 10 at school and is in the age range of 25-35.

Daphne was one of the few participants expressing a high level of confidence in her science ability. She is using beauty therapy as a stepping stone to get back into study. Daphne did a year of science at university when she left school, but described herself as too young and dropped out. Her aim eventually is to go into nursing and she chose beauty therapy because it included a range of science subjects. Daphne had the perception that science is a male dominated area. Daphne perceived her school science experiences as very good but in reference to mathematics where she really struggled, she made similar comments to those of other participants in reference to their science teachers, (see Chapter 5, Analysis of data). Her perceptions of her mathematics teacher were that she was not very good at explaining things and had difficulties managing the class. This teacher would then 'walk out' (Daphne, Interview, 2006) and Daphne felt that, as a consequence, the class 'missed hours of learning time'. Daphne also compared the teaching methods of two of her current teachers and stated that she preferred the teacher who gave clear explanations and used a lot of visuals and diagrams. The other teacher works from a text book and Daphne feels this is harder to follow.

Edward

Edward is Australian born of Australian parents and the language spoken at home is English. He has one younger brother. He completed Year 12 at school and is in the age range of 20-25. Edward attended a private school.

Edward perceived his school science teacher as using 'put-downs' and an intimidating manner to avoid questions (Edward, Interview, 2006). He stated that when he asked a question another student was told to read the answer from the board. This teacher taught by writing notes on the board and lecturing while students took notes. Edward's reaction was to 'switch off' because he was bored and had lost track. While he did not express anxiety about passing his current science subjects, his rating of his ability to do science was 4/10 which does not suggest a high level of confidence.

Florence

Florence was one of the older participants being in the age range of 40-45. Her parents are Hungarian and migrated to Australia when Florence was a very young child. She has an older sister and brother and also a younger brother. The language spoken at home is English. Florence was educated in Australia and completed Year 12 at school.

Florence, like Daphne, was confident about her science ability. She described her school experiences in science as very good and engaging. Her teacher was enthusiastic and made links to industry and the world generally so that the science was both interesting and relevant. Florence contrasted her school science teacher with her business studies teacher who Florence perceived as having no personality, being boring and not making clear the various applications. Florence also experienced difficulties with her mathematics teacher because she missed several weeks of school and the teacher made no effort to assist her in catching up, with the result that she became lost. Florence stressed the importance of a

teacher being enthusiastic about the subject they teach and also of taking an interest in their students. Florence did encounter gender bias from her father and at school where girls were encouraged to take business subjects and the careers of her brothers were seen to be more important than hers.

Gillian

Gillian was the oldest of the participants in the 45-55 age range. Gillian has an older brother and was born in Australia of Australian parents. She attended a 'strict' Catholic girls' school (Gillian, Interview, 2006), and left school after completing Year 11. The language spoken at home is English.

Like Florence, Gillian experienced gender bias. Her father was 'dominating' (Gillian, Interview, 2006), and insisted she take an office job rather than her preference of nursing. Gillian's perceptions of her school science were positive. She stated that she had always been interested in how things worked and that at school there was not a lot of practical work but Gillian enjoyed it because 'we got to do experiments and you could actually see it happen' (Gillian, Interview, 2006). However, she did also say that it was a strict Catholic school and they were taught by nuns who Gillian perceived as having little life experience so that the relevance of their science was not always clear to them. Gillian amplified her perception that life experience was important in a teacher by comparing a lay teacher they had for geography who took them on field trips and generally brought out the relevance of their studies. Much of the teaching in Gillian's science classes was taking notes from the board. However, Gillian stressed that it was interesting to her. The other problem occurred when Gillian was in Year 11, the school amalgamated with a boys' school. Gillian's perception was that the girls just got lost. It was also clear from Gillian's description that there have been considerable changes in schools and also society since she was at school. Most of Gillian's knowledge and awareness of science has been learnt as an adult. She has worked extensively in secretarial and administrative roles in medical clinics and also in intravenous fertilization (IVF) clinics. Her husband is a doctor and she has been exposed to considerable influences from there through medical journals and also friends. However Gillian did start with a positive attitude towards science from school and although her father would not allow her to do nursing, she pursued her interest by obtaining office jobs with a medical orientation. Although she really enjoyed working in the IVF area, Gillian was not comfortable with some of the moral issues and decided to switch to Beauty Therapy.

Harry

Harry was born in Australia although his parents are Scottish. He has a sister who is seven years younger than him. The language spoken at home is English. Harry is in the age range of 20-25 and completed Year 12 at school.

Harry was the second male participant and like Edward came across to the interviewer as not being anxious about passing his science subjects, although he also rated his ability to do science at 4/10. Harry stated that he wished he had worked harder at school in science because he has to do the science now. Harry described his early school experiences in science as fun but found it increasingly boring. His description of his science teachers was that they always came to school and did things but that the more interesting subjects were where the teacher told stories and made it interesting. He felt that his science teachers could have used more colour and visuals and made more effort to involve the students.

He commented that they had very large classes of thirty or more students and that this was a limitation.

Harry is interested in science and watches science programs on television and contrasted that where graphics and clear descriptions are used with his school science.

Harry made the interesting statement that he did not know and was not taught the 'language of science' and so could not 'read' the story (Harry, Interview, 2007). He also stated that his teacher used to embarrass him in front of his peers by asking a very technical question when he had lost interest. Harry stated that often the school science was not relevant to him and made the point that there was little connection between the theory and practical work and that their school laboratory equipment was old and dirty.

Kylie and Lucy

Kylie and Lucy were interviewed together at their request. This request was agreed to because they did not attend the same school and are class mates but not close friends. The situation arose when Lucy said she would volunteer if someone else came with her. Kylie who was sitting on the opposite side of the classroom said she would come. The researcher recognises that there could be some influence from each other but their transcripts are included because this was not apparent during the interview and because the comments they made were similar to those of other participants.

Kylie

Kylie was born in Australia and her parents are Australian. The language spoken at home is English. Kylie has a younger sister. Her age range is 20-25 and she completed Year 12 at school.

Kylie described both her science and mathematics teachers as 'pretty bad', (Kylie, Interview, 2007). From Kylie's description, the discipline was poor. She described her teachers as continuing to talk regardless of whether anyone was listening while students 'threw things', (Kylie, Interview, 2007). Kylie also commented that her science class was large with more than thirty students. Kylie recognised that this imposed limitations on the amount of time a teacher could spend with each student.

Kylie expressed fear of her school science teacher and stated that when she was at school she was afraid of getting into trouble if she asked questions although she now says that she would not have got into trouble but that was how she felt at that time. Kylie also commented that at TAFE, when she asked a question, it was answered not ignored. At school, Kylie's perception was that if she did not understand something the teacher thought it was because she was not listening. When she asked a question, Kylie's perception was that her teacher would ignore it or just repeat the same thing again which did not help her understanding. She suggested that her teacher should have tried a different approach when she did not understand something.

Kylie commented that her school teachers were not passionate about their subject and were boring. She had the perception that they did not want to be there. Kylie compared them to a supermarket checkout salesperson just doing a job. Comparing her current TAFE courses in science with her school science, Kylie stated that the TAFE approach was very systematic and Kylie is finding her TAFE science interesting and relevant. In reference to her school science, Kylie commented on the lack of relevance to her at the time of what they were studying.

Kylie thought that she was influenced against science by peers to some extent but that this was not a major factor for her. Kylie commented on the amount of pressure put on young children to do well. This comment was echoed by Therese.

Lucy

Lucy was born in England of an Australian father and English mother. The language spoken at home is English and the family migrated to Australia when Lucy was very young. Lucy has one older brother and at 18, was the youngest of the participants. Lucy's schooling was in Australia. She completed Year 11 at school.

Lucy expressed considerable anxiety about passing her current science courses and was horrified when she found she had to study science in Beauty Therapy. However, now, Lucy can see the relevance of her science and is finding it interesting. While at school, Lucy completed the Victorian Certificate of Applied Learning (VCAL) for some subjects, and found that she was more comfortable with the approach used in the VCAL courses, and learnt more. Lucy described the VCAL approach as 'learning by doing' rather than by reading and writing, (Lucy, Interview, 2007).

Lucy's perception of some of her school teachers was that they were really intimidating. Lucy had the perception that if she asked a question, she would be embarrassed by the teacher's sarcastic comments. Lucy commented that part of the reason she felt intimidated by her science teacher was that she made 'side comments' (Lucy, Interview, 2007). This perception was based on answers given by her teacher to other students. Lucy stated that they had one science teacher from whom you could not ask questions and that she would ask other people such as the course coordinator, her parents or friends first and only ask her teacher if she was 'super stuck', (Lucy, Interview, 2007). Lucy stated that her science classes were large with thirty or more students which similarly to Kylie, she recognised limited the time a teacher could spend with a particular student.

Therese

Therese's parents are Italian in origin, but the language spoken at home is English and Therese was born in Australia. She is the older of two girls in the family and completed Year 11. Therese initially attended a Catholic college from which she was expelled at the end of Year 10 and she completed her school education at a state secondary college. Therese was also one of the younger participants being 18-20 at the time of interview.

Therese's story is particularly interesting as it documents the change from an able student doing well, through disengagement to active rebellion leading to expulsion from her school. According to Therese, this all came about through one particular teacher (Therese's science teacher in Year 9). Therese's perception of her science teachers at school was that they were only interested in the students who were doing really well and let the other students 'fall behind', (Therese, Interview, 2007). Therese said that she enjoyed science in primary school and in Year 7 and Year 8. Her description of her school science up to this point was of considerable practical work involving class projects. Therese showed obvious enjoyment of her early science classes. Then she started working from a text book. Her perceptions of this book were that it mainly comprised images of burnt hands, cuts and a lot of difficult text. Therese said that she started falling behind and was unable to get help. Her questions were ignored or ridiculed. Therese did comment here that she was a 'bit of a class clown' and would often talk when it was not necessary. When her questions were answered the question was simply repeated, which did not help Therese in her understanding. This is a similar comment to that of Kylie reported above. Therese's perception was that her teachers were unwilling to give her any extra time to help her and her response

to her perception that she was ignored was to deliberately rebel. In her words, she set out to 'give her teachers grief', (Therese, Interview, 2007). This is something Therese now regrets, but it is an indication of the level of distress felt by Therese that a student who was at one stage enjoying school and performing well (by her account), should be so desperate. Therese then took to missing classes rather than be in a situation where she did not understand what was going on. Her behaviour eventually became so disruptive that she was expelled from the school. She was allowed to complete Year 10 (and passed it), by collecting set work and returning it for marking but she was not allowed to attend classes. She sat her examinations in the principal's office. The school was a Catholic Academy and Therese went from there to the local state secondary college. She hated this and played truant frequently. This meant she had to repeat Year 11 and she ended up dropping out of school altogether.

Vanessa

Vanessa is Australian and the language spoken at home is English. Vanessa has an older brother and a younger sister. Vanessa was 18-20 at the time of the interview and she completed Year 11 at school.

Vanessa has the perception that science is too difficult for her. However when questioned, Vanessa described performing satisfactorily in science until she reached Year 9. Her perceptions of the teacher she had in Year 9 were that he wrote everything on the board and did not explain anything. The students were then told to copy this into their books, whereas teachers she had for science prior to Year 9 explained things a lot more. Her Year 9 teacher discouraged questions. When Vanessa asked a question, she was told to read the answer from the board. The students were then set questions to do. The practical work was also not explained but Vanessa felt she could cope with it because it was set out like a recipe and she just had to follow the directions. Although Vanessa is convinced that she will fail in her current science courses, she did actually pass her school science despite her perception that it was too difficult for her. Vanessa tried a number of avenues to get help including from her year level coordinator as a last resort but was not successful and really found no one who could help her. She stated that she got lost in the first session of Year 9 and her questions were not answered so that she became more and more confused throughout the year. Vanessa also described herself as 'doing really well', (Vanessa, Interview, 2007) in other subjects including in mathematics which suggests that she is not lacking in ability.

Xandra

Xandra has Turkish parents but was born in Australia. She is the youngest in a family of three girls. At the age of twelve, Xandra spent a year in a Turkish school and then completed her schooling including Year 12, in Australia. Xandra is in the age range of 20–25. Both Turkish and English are spoken at home.

Xandra described science as being too difficult and expressed a lack of confidence in her ability to pass her current science subjects. She has worked as a medical receptionist for several years and so has acquired some knowledge of scientific terminology but her perception is that she does not understand it. Xandra ascribes this lack of confidence to being unable to approach her teachers in school with a question. Her perception was that if she still did not understand after something was explained it would be embarrassing to ask for further clarification as it would make her appear stupid. Her perception was that if a teacher is 'snobby' (Xandra, Interview, 2007), then you cannot approach them. However if a teacher is approachable and explains in simple terms, then you can ask until you understand. Xandra also stated (similarly to Therese) that the teacher would spend time and answer questions only for students who were good at science. Xandra had the perception that if she did not like a teacher, then she tended

not to like the subject taught by that teacher. This made her feel that she did not want to go to that class or even to school. As with Vanessa, Xandra described her science teacher as just writing notes on the board and not explaining anything. Xandra said she used to be unable to take in the information and would just go blank and write the notes without anything registering. She described her teachers as just doing their job – walking in, teaching, and then walking out - discouraging any further interaction. Like Harry, Xandra liked the teachers who cracked a joke or made a story out of the information so that it was interesting. Xandra suggested that it would have been easier if they could have had some group or discussion work in their classes. Xandra stated that she was immature at school.

Yvonne

Yvonne has Turkish parents but was born in Australia. Like Xandra, she spent some time in a Turkish school but the remainder of her schooling was in Australia. Yvonne completed Year 12 and stated that her religion was Muslim. (None of the other participants mentioned religion and the researcher did not enquire about their religious beliefs). Yvonne has an older brother and an older sister and both Turkish and English are spoken at home although Turkish is the main language spoken. Yvonne is in the age range of 25-35.

Yvonne was the other participant of Turkish background and stated that she did very little science at school. She declared that she chose Legal Studies instead of science because she 'hated' the science teacher, (Yvonne, Interview, 2007). (Yvonne had had that particular teacher for another subject previously). This was despite the fact that she has an obvious interest in science and watches science programs on television. In addition, Yvonne has a nine year old son and spends a lot of time doing science experiments from books with him. Because her parents moved a lot, Yvonne went to eight or nine different schools plus some schooling in Turkey. There were a sufficient number of different schools that she could not remember them all and some she was at for only a few weeks or months. She has also completed a tertiary diploma in Turkey. Moreover, while Yvonne's spoken English was very fluent; she stated that her written English was only 'about 80%', (Yvonne, Interview, 2007). This would have made science more difficult for her if she had a teacher who wrote notes on the board and gave limited explanations.

Both Xandra and Yvonne spoke fluent English.

Zara

Zara has Egyptian parents but was born in Australia and the language spoken at home is English. Zara has three older sisters and a younger brother. She completed Year 12 but is also one of the younger participants being 18-20 at the time of the Interview.

Zara described science classes as largely copying notes from the board and then working exercises from her textbook. Zara commented that her teacher discouraged questions and gave limited explanations. Like Kylie and Yvonne, Zara felt that her science teacher did not seem interested in the subject and asked how could they (the students), be interested if the teacher was not interested. When probed about other subjects and her current science courses, Zara commented again on the advantages of having interested teachers and a wider range of class activities than board work and talking. Zara did not have any gender influences that she was aware of. Her comments on the possibility of peer pressure also do not suggest any strong influence there.

The interview transcripts were analysed using a coding process as described by Agar, (1980). This process of data reduction is described in detail in the methodology of Chapter 3. The coding resulted in the extraction of a number of themes. Chapter 5, which follows, analyses and discusses these themes.

CHAPTER 5: THEMES EXTRACTED FROM THE INTERVIEWS

Introduction

The first part of this chapter reports the themes extracted from the stories of those participants who did not feel confident about their science. The extracted themes were then analysed with respect to the individual participants. Most of the participants described poor experiences of science at school - their stories were then contrasted with the stories of those participants who enjoyed good school science experiences and also with the science experienced in the participants' current Technical and Further Education [TAFE], courses. In addition, some of the experiences listed by the participants in connection with those subjects in which they did well at school are compared with their experiences in their school science courses.

The second part of this chapter reports the effects of other factors such as peer influences and gender on the development of attitudes towards and confidence in science. Finally some other minor points brought out by participants are discussed.

The dominant themes expressed by participants who did not feel confident about their science ability

Examination of the science stories of the participants in the current study shows that the participants perceived their teachers as playing a crucial role in developing or destroying their confidence in their ability to do science. Those students who expressed low levels of confidence all described poor school experiences in science. None of them expressed a problem associated with any other influences. It is important to note that the themes identified are those relating to the participants' perceptions and impressions and may not reflect teaching practice. However, there are sufficient similarities between these stories to suggest that there are considerable problems in the science teaching area. By a process of progressive analysis of the transcripts, twelve themes were identified which were common to a number of the participants and which were teacher related. A further group of themes were identified which were student related. This latter group is discussed later in this chapter. Other areas probed in the interviews were the effects of peer pressure and gender or cultural issues. No consistent themes emerged from these latter probes; comments and perceptions in these areas are reported.

SECTION 1: Teacher related themes

The teacher related themes have been categorized by the researcher into four main clusters but because of their nature, there is overlap between clusters. These clusters are:

A. Pedagogy: this relates to the teaching methods employed by their science teachers as perceived by the participants. Themes identified in this cluster were:

1. Students expected to learn from board notes or textbooks
2. Limited or poor explanations given with practical work – students effectively just following a set of instructions with no opportunity to explore or create inquiry questions
3. Boring presentation
4. Poor class discipline

B. Attitude to students: this concerned the perceived attitudes of their science teachers towards the participants. Themes identified in this area were:

5. Lack of respect demonstrated by teacher for their students which included 'put-downs' and in some cases active intimidation of students by teacher.

6. Impression given by teacher that science is difficult and complex and beyond the abilities of a particular student

7. Unfair treatment

8. Lack of enthusiasm by teacher

C. Response to students: this group of themes overlaps with groups A and B as it concerns both pedagogy and attitude to students. Themes identified here were common to many of the participants and included:

9. An unwillingness to answer questions.

10. No help given even after repeated requests

D. Relevance: this group of themes concerned the extent to which the relevance of their science lessons was made clear to the participants by their science teachers. These themes included:

11. A lack of relevance to the participant of topic studied or the relevance not explained in a manner that was clear to the participant.

12. Poor link between theory and practical work so relevance of practical work was not clear. Several participants described a considerable time gap between their practical exercises and the relevant theory.

These themes in clusters A-D are tabulated according to each cluster to which they have been allocated in **Table 2** below.

Table 2: Teacher related themes by clusters

CLUSTER	(A) PEDAGOGY	(B) ATTITUDE TOWARDS STUDENTS	(C) RESPONSES TO STUDENTS	(D) RELEVANCE
Themes	(1) Students expected to learn from board notes or textbooks	(5) Lack of respect demonstrated by teacher for students including "put-downs' and in some cases perceived intimidation of students by teacher	(9) An unwillingness to answer questions	(11) Lack of relevance to student or relevance not explained
Themes	(2) Limited or poor explanations given with practical work – students effectively just following a set of instructions with no opportunity to explore or create inquiry questions	(6) Impression given by teacher that science is difficult and beyond the abilities of a particular student	(10) No help given even after repeated requests	(12) Poor connection between theory and practical work
Themes	(3) Boring presentation	(7) Unfair treatment		
Themes	(4)Poor discipline	(8) Lack enthusiasm by teacher for subject being taught		

Note: The numbers in the brackets refer to the numbers in the list above (pp.56, 57)

When these themes are tabulated with respect to particular students, it can be clearly seen that most of these were experienced by a number of participants in the study. It can also be seen that three participants described few experiences in relation to these themes. Two participants (Gillian and Florence), were the mature aged participants mentioned previously and together with Daphne expressed a high level of confidence in their ability to do science.

Table 3: Participants demonstrating themes identified in the study

CLUSTERS	A				B				C		D	
THEMES	1	2	3	4	5	6	7	8	9	10	11	12
PARTICIPANT												
Annabelle					X	X	X		X	X		
Bertha	X	X	X			X			X	X	X	X
Constance	X		X		X				X	X	X	X
Daphne				**X								
Edward	X		X		X				X			
Florence												
Gillian												
Harry	X	X	X		X			X			X	X
Kylie			X	X	X			X	X	X	X	
Lucy	X		X	X	X	X		X	X	X	X	
Therese	X						X		X	X		
Vanessa	X	X	X			X			X			X
Xandra	X	X	X		X	X	X	X	X			
Yvonne*	X		X									
Zara	X	X	X					X	X	X		X

Notes:

X denotes a positive response to the theme

*Yvonne studied very little science at school, apart from some environment and health education. She did not feel comfortable with even these small sections of science as she had developed a strong antipathy towards the science teacher, who she had for other subjects.

**This was described in reference to Daphne's mathematics class in which she struggled but is included because it is relevant

The following section provides a detailed discussion of each of the teacher related themes with examples from the transcripts.

Cluster A: Pedagogy

This section examines the themes relating to pedagogy of the participants' science teachers – as the participants perceived it when they were school students. Each theme is illustrated with excerpts from the transcripts in the participants' own words which were often very powerful.

Theme 1: Students expected to learn from board notes or textbooks.

Many of the participants stated that their science lessons mainly consisted of copying notes from the board and working examples from their notes or from textbooks. Xandra commented that she enjoyed the practical side of science but the theory was presented in a boring way, where the students were just required to copy notes from the board. Xandra also stated that she used to go blank and not understand

anything she was reading. Her description expresses very clearly the confusion she felt and the difficulties she had in understanding the work. This is also a symptom of science anxiety, (Mallow, 1978).

> They did it on the board. They write, write, write, and write. They explain everything, and it's like you just…I don't know, it's like you just go blank. It's like they've just written so many things on the board and explained so much, and it's like I'm lost! I don't know, where we are, what we're doing. It's just; I think it's just the way that…It's not enjoying…, (Xandra, Interview, 2007).

Harry's perception was that most science teachers read from a textbook and he had difficulty concentrating and tended to 'switch off'. Harry would have preferred a more interesting approach where the students were more involved and he could follow the 'story'.

> Like most [science] teachers kind of read from a text book, (Harry, Interview, 2007).

Vanessa enjoyed science until she had a particular teacher who expected the students to work from board notes or their textbooks and would not answer any questions. Vanessa's Year 9 science teacher taught, by writing notes on the board, which the students were required to copy into their books. No explanations were given and if the students asked questions, they were just told to read the notes or their textbook. They then worked on exercises from their textbook.

> I don't know. The other teacher, [in Year 7/8], would explain it a lot more and go into more detail so that we'd actually know what they were talking about, whereas he, [Year 9 teacher], would just like, write it up and say, write this down in your books. And then he'd just give us work but we still wouldn't understand and we'd just be like, yeah, but how does that work with that? Yeah, we were just expected to realise what was happening but we had no idea, (Vanessa, Interview, 2007).

Vanessa found that she eventually could not cope with science as there were no explanations and it was all copying notes from the board.

> I don't feel I can cope with it.... It seems too hard.
>
> …my science teacher was a bit…I couldn't really understand him [he would] write everything on the board, and then he didn't really explain it, (Vanessa).

Vanessa was asked what she would have preferred:

> More explained and not, all like, writing. And if we're going to write it, then write about it then speak about it all, and then ask questions or whatever. Something like that. What everybody can understand, because most of us didn't understand it in that class, (Vanessa).

Therese noted that she was required to do most of her learning from the textbook.

> And you hit high school and you have textbooks. I never knew what textbooks were in Year 7. I found out they were these big things with just writing and writing that you had to read and that's where I'd get the majority of my information from. And it just became writing pretty much, (Therese, Interview, 2007).

In Therese's case, her memory of her science textbook was predominantly of images of burnt hands and cuts which Therese found upsetting:

> It was all images of burnt hands and cuts, (Therese).

Edward commented that he enjoyed science until Year 9 or Year 10 and then the teacher he had then would work mainly from a textbook or the board.

> In Year 9 or 10 we got the senior science master and he would read from a textbook or write on the board and we had to take notes and then answer questions, (Edward, Interview, 2006).

Zara had difficulty trying to keep up when her teacher, who was talking, was writing things on the board at the same time:

> She would talk and write on the board at the same time and you couldn't copy and listen at the same time or I couldn't. I lost focus because by the time I'd written stuff down she was talking about something else. Then we had to answer questions from our books, (Zara, Interview, 2007).

Theme 2: Limited or poor explanations given with practical work – students effectively just following a set of instructions with no opportunity to explore or create inquiry.

An important aspect that was raised by several participants concerned their practical work. From their descriptions, there was no opportunity for students to develop their own science inquiries. Most of the participants reported enjoying their practical work, but it was in many cases poorly explained. Bertha gave an excellent example, (mentioned previously on page 48), when she compared the lesson she had at school where they dissected chicken breasts with the same lesson at TAFE, where the teacher explained with the use of visuals and diagrams the similarities between the structures of the chicken breast with that of the human arm. This made sense to Bertha who could then understand why they were dissecting the chicken breast, whereas at school, they had just been told to find the muscles and tendons and the link with the human arm was not explained.

> Here, [at TAFE], when we did the chicken breasts the teacher said, 'Well, this is how your arm moves,' and explained how it works in the human body as well. So I could relate to that, but in high school they didn't relate it back to the human body so I couldn't really understand. Year 8, I think it was, we dissected a chicken breast or something, looking for the ligaments in it. Here at VU they explain how it relates to the human body, but there they didn't. They were just talking about the chicken, so I couldn't relate to it so I didn't see the point in it at the time-understand what they were trying to get at, (Bertha, Interview, 2006).

For Vanessa, the practical classes were conducted via her textbook effectively like using a recipe. This meant that the experiment was usually successful, but without a link to the theory, much of the value was lost. Vanessa said you followed the directions and the experiment worked. However this would have been like following a recipe without knowing what you were making.

> That was okay, because all you had to do was look in the book to see how to set it up and… [It was] kind of done, (Vanessa, Interview, 2007).

Harry observed that the equipment and the laboratory at his school were old. He was sufficiently interested in science to watch science programs on television and contrasts this where they use bright colours and do experiments.

> We had old things and an old lab room, (Harry, Interview, 2007).

> [TV programmes] after school that I always enjoyed watching and they were, they did different experiments … and there's lots of bright colours and music, (Harry. Interview, 2007).

Although both Kylie and Lucy did some science in primary school, the actual science was not made clear. For example, both remembered 'doing' volcanoes, but the relationship to actual volcanoes was not understood by either of them as it was not explained at the time that they were using a model which represented the effects of a volcanic eruption. When asked if they had understood what was happening:

> Not really. Not at all, (Lucy, Interview, 2007).

> You put that in there and that in there and it goes boom, (Kylie, Interview, 2007).

Theme 3: Boring presentation.

Many of the participants found their school science boring and some described teachers who themselves lacked enthusiasm or interest. Bertha started off very keen to do science but gradually lost interest. This loss of interest, Bertha perceived as being caused by the way her school science was presented:

> Well, I was all for learning in high school about the science but the teachers didn't really make it interesting and I think that's where I lost my interest for science …

> Like, they didn't teach it properly, (Bertha, Interview, 2006).

From finding science fun in Year 7, Harry became progressively bored and disengaged. He could not follow the 'story' as he felt he did not understand the language of science

> …they tended to be the more boring [science teachers]... Like, others, like my favourite teachers would have been fun like telling stories and things, (Harry, Interview, 2007).

Harry added that if he were to teach, he would try to involve the students more including those students who were quiet and did not say much

> …they {science teachers} were very good at what they did, I suppose. Like, they always came to school and they did things, but if I was to teach, I would try and engage the students a bit more and to find out where they're at and try and make them feel [involved] in it as well. Even the ones [that are] quiet and not speaking…, (Harry).

Kylie noted that not only did her teacher present material in a boring way, but the teacher herself also appeared to be bored.

> If they're like boring and they're not passionate about it. It was sort of like sometimes they didn't want to be there, (Kylie, Interview, 2007).

Theme 4: Poor discipline.

Several participants referred to poor discipline in their science classes. Kylie felt that her science teachers made little attempt to impose discipline and just kept talking over whatever disruption was occurring. Lucy agreed with this comment.

> A lot of them [school science teachers] just keep talking, whether you were listening or not. They'd just keep trying to drill it into you, (Kylie, Interview, 2007.)
>
> Yeah that's right, (Lucy, Interview, 2007).
>
> Or they'd [other students] would just keep talking and throwing things or whatever. There was no discipline, (Kylie).

As previously reported, this comment was echoed by Daphne in reference to her mathematics classes. Daphne describes her year 12 mathematics teacher as frequently walking out so that they missed out on hours of learning time.

Several participants, (Daphne, Harry, Kylie and Zara) commented on large classes with thirty or more students and they recognised the limitations and pressures that this imposed on their teachers.

Cluster B: Teacher attitude

Theme 5: Lack of respect demonstrated by teacher for participants including 'put downs' and perceived teacher intimidation of student.

Many participants indicated that they had suffered 'put downs' and intimidation from their science teachers. Participants felt that they had experienced a lack of respect demonstrated by these teachers. This area is important because, for many of the participants, questions were discouraged by the perceived use of an intimidatory manner adopted by their teacher, or by humiliation in front of their peers. This applied to the extent that Kylie, Constance and Lucy all expressed fear of their science teachers while they were at school. The way in which this lack of respect was demonstrated was by derogatory or sarcastic remarks and by humiliating students in front of their peers. For example, Annabelle's science teacher suggested that she should go and work in a factory for the rest of her life, and she would not give her a reference.

> Like she was just if you don't do well in year 12, you can go and work in a factory for the rest of your life….
>
> I'd start looking for a job now if I were you. I asked her for a reference and she just said no, (Annabelle, Interview, 2006).

Annabelle also stated that when she went to another teacher and told her what had been said, that teacher was shocked. She felt that she had never really got over it or forgotten it. It was clear at the interview that this had been a very distressing experience for her.

> I'd like to see her today and tell her what I've done with myself since year 12 because she just wrote me off for nothing pretty much, (Annabelle).

Edward described the way in which he was made to feel stupid by his science teacher; although he also suggested that maybe he was not really listening at the time:

> Well, he made me feel stupid in front of the others and he used to make me sit at the front of the class and then make remarks about me as a joke, (Edward, Interview, 2006).

When asked about these remarks, Edward gave an example:

> Like say 'Since [Edward] knows so much about it perhaps he could come and explain to the rest of the class' or once when I asked a question, he got someone else to read the answer from the board and I felt really stupid, but maybe I wasn't really listening, (Edward).

Constance also described humiliating and intimidatory behaviour by her science teacher to the extent that she was actively frightened of going to science classes. This is also an example of science anxiety, (Mallow, 1978). Her comments about her first TAFE science class indicate the importance of a student feeling safe and comfortable in class. Her experiences conflict with both Maslow's hierarchy of needs, Maslow, (1943), and also the first principle of PoLT, 2001, which specifically states that the learning environment should be supportive and productive. Maslow's theory was that the needs at the base of his pyramid had to be met before personal growth could occur and safety needs are among the most basic needs listed in Maslow's pyramid. Constance's school experiences were so bad that she was terrified of her first science lesson at TAFE and thought that this was normal.

> On the first class [TAFE] that we had for anatomy, I obviously was terrified, (Constance, Interview, 2006).

This fear was recognised by her TAFE teacher who took steps to reassure her.

> …I didn't realise that I looked terrified but the teacher came up to me at the end of the class and said, 'Look, you look really worried' and she just reassured me that it will be okay. That if I have any trouble with anything that she is there to help, and to ask for help if I need it. So that gave me real reassurance and made me feel more confident in myself, so that helps a lot as well, (Constance).

Kylie also commented on being frightened of her science teacher while at school and Lucy agreed that some teachers were very intimidating and both Kylie and Lucy dreaded their science lessons.

When this intimidation was probed with Kylie and Lucy, there was a strong perception that if they asked questions they would be humiliated in front of their peers or even 'get into trouble', (Kylie, Interview, 2007). It is of concern that Kylie was afraid of getting into trouble for asking a question. Lucy recognised that the intimidatory manner was associated with the way the teacher taught but Kylie just had the perception that her teachers were mean.

> Like some you were really scared of, (Kylie, Interview, 2007).
>
> Yeah, they were really intimidating, (Lucy, Interview, 2007).
>
> They were mean, (Kylie).
>
> Not sure if they were mean. Just the way they sort of I don't know, taught. Or the way they sort of did things or maybe just some of the sort of side comments they'd say. Like if they said it to

another student or something, you'd be like well I'm not going to say anything, because they'll say exactly the same thing; how embarrassing, (Lucy).

Or be in trouble or something, (Kylie).

Or just sort of feel a bit humiliated, (Lucy).

Lucy clearly had some understanding that her teachers were not mean but she also had the strong perception that they used intimidation and discouraged questions via sarcasm.

Theme 6: Impression given by teacher that science is difficult and complex and beyond the abilities of a particular student.

Both Bertha and Annabelle were given the impression by their respective teachers that science was too difficult for them and they lost confidence as a result of this to the extent that Bertha had serious worries about her ability to cope with her current science courses.

> Like I always have that attitude that whatever I want to do if I put my mind to it I can do it, but then when someone turns around and says, oh it's very hard and you're going to find it difficult to cope it does make you think twice and think maybe it is out of my league to try and do science. So I was really worried about starting the science, (Bertha, Interview, 2006).

Bertha then decided that since she had to do the science she would just aim for a pass but having started the course she is now interested and more confident and is aiming to do better although she still has a very low confidence, (one out of ten), in her ability to succeed in her science courses.

> I just thought oh well, I just have to do it and just pass and that's all I thought, like if I need 50% to pass I'll be happy with 50% pass but now I look at it as though I want to do well in it because I want to understand it, so I'm aiming for higher than that now. I want to know what I'm doing. I don't want to just pass. I want to understand it, (Bertha).

Theme 7: Unfair treatment.

Two participants felt that they were unfairly treated by their science teachers and this reflected on their subsequent attitudes to science. It was noted here that it is unlikely that teachers were actively unfair to their students, but it was given as part of the reasons for participants to have poor confidence in their science ability. Therese had the perception that her teachers were only interested in those students who were doing well and would let the others fall behind:

> If you struggled in class, they [her teachers] wouldn't pay attention. They'd let you fall behind and keep with the students that are up and forward if that makes sense, (Therese, Interview, 2007).

Therese also suggested that they were unwilling to answer her questions.

> They weren't willing to answer questions–my questions, anyway, (Therese).

Annabelle gave as an example of unfair treatment the fact that she and her friend would be given a lower mark than other students for the same answer. She interpreted this to mean that the teacher did not like her. She stated that this was the reason why she did not continue with science. The researcher notes that this comment is likely to stem from Annabelle misunderstanding the standard of work required rather than from her teacher treating her unfairly. However this statement of Annabelle's is included here because of the indignation expressed at the interview indicating that Annabelle's perception of unfairness was very strong:

> In Year 11, I did biology and my teacher was really, really nasty, and that's why I didn't follow through, because she'd just…my friend and I she didn't like us and we'd answer the same questions as everyone else yet we'd get a much lower score and it just wasn't fair. So I didn't continue through with it, (Annabelle, Interview, 2006).

Theme 8: Lack of enthusiasm by teacher.

Four participants stated that their science teachers lacked enthusiasm and that this reflected on their own interest in science. Kylie stated that it was as if her teacher did not want to be there. When probed on this statement, Kylie likened her science teacher to a cashier in a supermarket – someone who is just doing a job, not incompetently, but as if she did not want to be there

> Yeah, you know when you go through like, a register check-out chick and she's like, she doesn't want to be there; same sort of thing, (Kylie, Interview, 2007).

Xandra described her teachers as serious, never joking or smiling and just doing a job:

> …most of the teachers at our school were all just teachers. Full on teachers where you can't crack no jokes. The teacher won't crack a joke. Like, you probably hardly see a smile on their face. Like, they'll walk in, teach and then walk out. I just think most teachers were like that, (Xandra, Interview, 2007).

There were three participants (Kylie, Xandra and Zara) who all saw their science teachers as showing minimal interest and of simply arriving, teaching and leaving. Zara stated that her science teacher did what she was supposed to do but she had the perception that this teacher was not interested in the subject. When probed on this, Zara added that her teacher typically left immediately after classes, and she was not able to answer questions at the conclusion of these classes.

> I think it was the teacher like Year 10. I mean she did the stuff she was supposed to, I suppose but she wasn't interested herself, (Zara, Interview, 2007).

When probed on this statement, Zara elaborated and explained that there was no opportunity to ask questions and that her science teacher's presentation was boring,

> Well, she came, she taught, she left. You couldn't ask her anything and if you did in class she would just say to look it up. And she was boring, (Zara).

Zara stated that it was difficult to be interested in something if even the teacher is not interested although she also commented on the size of the class as a factor.

> I mean, it was a big class like there were about thirty of us but mainly you don't feel interested in something if even the teacher doesn't have that interest. She was just doing her job, I guess, (Zara).

(The importance of the teacher being enthusiastic is something that the researcher can testify is true from her own experience. When she was doing second year biochemistry, she looked forward with enthusiasm to learning about the biochemical cycles which at that stage represented biochemistry for her. The lecturer came in and said: 'This is a very boring topic – I don't want to be here, you don't want to be here but we have to get on with it'. It was a very demoralizing way of starting a new subject).

Cluster C: Responses to students

Theme 9: An unwillingness to answer questions.

Theme 10: No help given even after repeated requests.

These two themes have been analysed together because there is considerable overlap between them and they are closely related. Analysing participants' personal stories in detail, one dominant theme emerged concerning the teacher being unwilling to answer questions. This unwillingness was frequently associated with an attitude by the teacher towards the student, which was seen as disrespectful by the student, which also overlaps with Theme 8.

The participants described the use of sarcastic comments or remarks that made them embarrassed in front of their peers.

Bertha had a perception that that some teachers were not there to help her and so she could not ask questions of these teachers:

> ...and the ones, [teachers], that you know aren't there to help you, you can't ask for help so you can't do as well as you possibly could, (Bertha, Interview, 2006).

However, Bertha is a very able student with an A+ grade in mathematics. (This information was volunteered by Bertha during the interview). In contrast, Bertha described her mathematics teacher as 'really good' and stated that if she had any problems she was helped straightaway. Constance also cited an inability to get help in her science classes because of fear of her science teacher.

Both Kylie and Lucy were adamant that some teachers were intimidating and Lucy stated that you only asked them questions as a last desperate resort (if you were 'super stuck').

> I think it's different teachers... some teachers you can get along with and then you sort of feel you can ask them questions. Some teachers…we used to have this one science teacher and it was just sort of like you didn't ask any questions. You asked your friends before that and if you were really super stuck then you'd go and ask, (Lucy, Interview, 2007).

Therese found it very difficult to get help and started falling behind. She found her teachers unwilling to give any extra time or help.

> We had teachers that just wouldn't help you because you were falling too far behind. And also there were a lot of teachers at this school, not just the science teachers and it was like they just

> didn't have the time. They weren't willing to stay back after class and help you. They weren't willing to answer questions – my questions, anyway, (Therese, Interview, 2007).

Therese found that when she asked a question, it was ignored and not answered or if her teachers did answer, they simply repeated the question in another way rather than answering it. In response to a question about what happened when she asked a question, Therese replied:

> Disregard it. They would disregard it. They would just look at me and look away. They would answer it half the time, but they would just repeat the question that I've asked, in another way that did not answer the question, if that makes sense, (Therese).

Kylie's statement on questions, comparing her current TAFE course science subjects with her school science, is relevant here:

> Yeah and if you put your hand up and asked a question they didn't just go, 'huh', (Kylie, Interview, 2007).

Vanessa was told to 'just read the stuff' if she asked a question, (Vanessa, Interview, 2007).

Xandra feels that her attitude towards science may be a result of the way teachers taught and responded to her questions. When probed on this:

> I don't know. It's probably because you couldn't approach your teachers. And so to ask a question, like they'll explain it to you and if you think, no, I didn't still get it, so you'll be embarrassed to ask a second time, thinking that I need help on it, (Xandra, Interview, 2007).

She added that it was difficult to ask a question the first time and the second time she just could not do it:

> Not the second time. The first time, yeah, but I didn't think…I couldn't. Like, probably the first time it'd be really, really hard for me to even ask, the first time. But I just think it's just the way it's actually taught and explained, (Xandra, Interview, 2007).

Zara's description of her science teacher was succinct:

> She came, she taught, she left. You couldn't ask her anything and if you did in class she would just say to look it up, (Zara, Interview, 2006).

This complements Annabelle's statement that the teachers were not willing to answer questions after class or make any time available to help students.

Related to this theme is the inability of most participants to get help when they needed it.

Bertha compared her mathematics teacher who helped her straight away when she needed it with the result that Bertha was an A+ student in mathematics compared with science which was a struggle for Bertha because she was unable to get help.

> My maths was always really good, I was always A+, like my scores were always around 99 or 100% on every maths test I ever had. And that was because the teacher was good and I liked the teacher and she taught well and if I had any problems she would help me out, like straight away. So I always went really well in that subject because of the teacher, (Bertha, Interview, 2006).

Her mathematics results demonstrate that Bertha was a student with a high level of ability and she also persevered with her science and tried very hard to get the help she needed even going to the Year level coordinator.

> I didn't understand it and I wasn't given help to understand it, (Bertha).

Vanessa rated her ability to do science as very poor and described herself as lost in the first lesson of Year 9 when she encountered a particular teacher and from then on was experiencing difficulties. She initially asked questions and requested explanations or asked the teacher to slow down but was ignored.

> I'd always ask questions and like, I don't understand, and you're moving too quickly, or… it didn't stop him, (Vanessa, Interview, 2007).

Like Bertha, Vanessa went to considerable lengths to try to get the help she needed. Initially, she tried to get help from her course coordinator and then various friends. She had no one at home who was able to help her although her parents were aware that she was struggling.

> I tried to go to the coordinator and … and try and speak [to them] but they wouldn't know anything about it. So they were my last hope; and friends. Some of them were in a higher level and they understood it more and … so I'd ask them, (Vanessa).

Vanessa found that the course coordinator was not able to help her and went back to the science teacher and was told to read it. The description of the coordinator and friends being her last hope is an indication of the difficulty that this student experienced when she was simply trying to understand a topic. She was not in any way misbehaving or even particularly immature from her description. Also, like Bertha, Vanessa did very well in mathematics and so could be considered an able student.

As previously commented, Zara's comment (reported previously), makes it clear that her science teacher was not available to ask questions from after class. During her interview, Zara was asked what happened when she tried to approach her teacher after class with a question:

> You couldn't do that because the bell went and she was gone, (Zara, Interview, 2006).

Xandra also made a similar statement in reference to her teachers, reported above, although it was not in the context of getting help, it related to the availability of the teacher.

> Yeah. Just walk in, teach and walk back out, (Xandra, Interview, 2007).

Both Kylie and Therese stated that their teachers simply repeated their questions rather than answering them:

> Yeah, there's no point explaining something, so if you don't get it, you don't understand it, then explaining it isn't going to get it. If you try a different way that way might stick. Do you know what I mean? (Kylie, Interview, 2007).

> They would answer it half the time, but they would just repeat the question that I've asked, in another way that did not answer the question, if that makes sense, (Therese, Interview, 2007).

Another important issue was raised by Florence - the necessity for teachers to be aware of students' progress and to organize 'catch-up' arrangements when a student is absent and misses work. Florence

clearly linked absence and no catch-up work with a loss of confidence in a subject. Although these comments were made in relation to mathematics, they are also relevant to the teaching of science:

> I hit a wall with maths and my confidence went down. It's important for the teacher to follow student progress. Absence influences progress in continuous subjects, you can't catch up, (Florence, Interview, 2006).

Cluster D: Relevance

Theme 11: Lack of relevance to student or relevance not explained.

It is recognised that there are two criteria here but from the viewpoint of the student, they are indistinguishable. Therefore they have been considered together in this section. An important theme for the participants was relating what they were doing in a meaningful way. Bertha stated that her mathematics teacher always demonstrated the relevance of what she was teaching so that Bertha could relate it to something that was meaningful for her. Mathematics was a subject that Bertha did well in, so the contrast between the two teaching approaches is important.

> I like it when the teacher teaches you and relates it to something that's in your life so you can understand, (Bertha, Interview, 2006).

Constance stated that the relevance of what they did at in her school science classes was not explained, while Harry felt that the 'story' was not told and so he could not relate to it.

> You know how you can read a book and it tells you a story and you're engaged in it …when I read numbers, they're just numbers. They don't mean anything to me. [Instead] of reading the story or watching TV, where it's all just in a language that I know, I have to interpret it, (Harry, Interview, 2007).

This comment related to all sciences, although Harry also noted that if he was interested in something then he would research it himself in the library or on the internet but when he was bored, he switched off.

> I don't see any relevance in it I just switch off, (Harry).

> Drawing little pictures on my notepad probably, (Harry).

This was a case of the relevance not being clear to Harry although the teacher may have explained why it was relevant.

Both Kylie and Lucy enjoyed science initially, but as they progressed through school, they both lost interest in science–Lucy to the point where she actively hated it. However, Lucy has found that she enjoys science at TAFE and finds it really interesting but at school she did not see the point of it. Lucy's reaction on finding that the Beauty Therapy course included a number of science units was one of anxiety as she had not enjoyed her school science. However, she can now see the relevance of science to the Beauty Therapy course and is finding it interesting to see how it all fits together. So clearly Lucy did not see much relevance in her school science:

> Yeah, bit worried at first; because I didn't really like science at school, so I'm like ugh, science. But I think when you're doing the whole kind of course it all relates to each other, and it's all very interesting, (Lucy, Interview, 2007).

Kylie agreed that at school, the relevance of the science was not clear to her:

> Yeah, maybe that was the thing; at school, it didn't really apply, (Kylie, Interview, 2007).

Gillian, one of the mature aged students interviewed, enjoyed her school science. She felt however that the nuns who taught her were themselves limited in what they knew. She went to a Catholic school and compares the nuns with a lay teacher she had for geography, who was able to introduce some life experience into the lessons which Gillian found more useful. That is although she enjoyed her school science, she did not always see its relevance. Referring to the geography teacher, Gillian stated:

> He introduced a lot more life experience type lessons, which I think were more valuable to us, (Gillian, Interview, 2006).

Theme 12: Poor connection between theory and practical work.

Several participants commented that they had enjoyed doing practical work at school but that it did not always make sense to them because they could not connect it with the theory For Constance, there was a poor connection between practice and theory which meant that either the relevant theory had not yet been covered or had been covered some time previously. When asked about practical work, Constance said that she enjoyed it but did not understand most of it because it did not connect with the theory. Further questioning on this suggested that the theory was covered but not always before the relevant practical work or sometimes several weeks earlier. The other aspect of practical work identified was that in most cases participants followed a procedure like a recipe from their text books or notes with no clear idea of what they were doing.

Zara enjoyed her practical work and although the relevant theory was covered it was not at the same time as the practical work. This meant that the practical work was not meaningful for her.

> We did that and it was fun like we dissected things but it didn't make sense at the time because it wasn't what the writing was about or not when we did it, it wasn't. Zara, (Interview, 2007).

SECTION 2: Student related themes

Student related themes were concerned with student perceptions and reactions which were unique to each individual. However there were four themes which were shared by several participants. These themes are listed below.

List of student related themes

1. Self blame
2. Relationship to teacher
3. Not understanding the work

4. The influence of preferred learning styles

Self blame was the most dominant ranging from laziness, (Annabelle), not working, (Bertha), immaturity, Xandra), and inattentiveness, (Edward, Harry). The relationship to the teacher included truancy, (Annabelle, Edward, Therese), opting out in class, (Bertha, Edward, Harry) and deliberate disruption of classes, (Therese). Several participants described feeling lost and not understanding the work, (Bertha, Vanessa and Xandra). Prior to the interviews, the researcher had expected that not being taught by their preferred learning style would be the most dominant factor. This was a relevant factor experienced by most participants but not stressed by them. Many participants including those who expressed confidence in their ability to succeed in science stated that they preferred the way in which science was taught in their current TAFE courses with clear explanations, visuals and diagrams. More important to the participants than being taught by their preferred learning style was some variety in the teaching employed rather than constant writing and taking notes which they found boring.

Table 4 below shows which participants experienced these student-related themes.

Table 4: Student related themes experienced by participants

Participant	Theme			
	1	**2**	**3**	**4**
Annabelle	X	X	X	X
Bertha	X	X	X	X
Constance			X	
Daphne				X
Edward	X	X	X	X
Florence				X
Gillian				
Harry	X			X
Kylie		X		
Lucy		X		X
Therese		X	X	
Vanessa			X	X
Xandra	X	X	X	X
Yvonne		X	X	X
Zara				X

Theme 1: Self blame.

Several of the participants blamed themselves for their lack of understanding and progress in science. Annabelle stated that she was lazy and non-academic and did not study with the result that she did not do as well as she was capable of doing. Annabelle described her attitude to science as being lazy, but when probed on this, said that if she doesn't understand something, she will let herself fall behind.

> And if I don't understand it to begin with then I just fall behind. Let myself fall behind. I still pass though, just. But I don't get 100%, (Annabelle, Interview, 2006).

Annabelle also stated that although she thought of herself as non-academic, her marks didn't support this belief.

> I've sort of decided that I'm not very academic, which is not true because my marks are sort of showing differently, like if I compare to my friends they'll study and I won't and I'll still get either higher than them or whatever, but…I'm just lazy, (Annabelle).

Bertha said that obviously, she didn't work properly when she was unable to see what she was supposed to see in some microscope work. This resulted in her regarding it as a waste of time.

> I obviously didn't work properly and I didn't see what I was supposed to be seeing and once again, I wasn't shown how to do it properly. Yeah, I just thought it was a waste of time, (Bertha, Interview, 2006).

As reported earlier, Edward, after describing being made to look stupid in front of the class, suggested that he wasn't listening:

> Once when I asked a question, he got someone else to read the answer from the board and I felt really stupid, but maybe I wasn't really listening, (Edward, Interview, 2006).

Xandra stated that she was immature which reflected on her ability to ask questions.

Theme 2: Relationship with Teacher.

A very important aspect for the participants was whether they felt they could relate to the teacher and were respected by them. Aside from the aspect already described about feeling so intimidated by some teachers that they were unable to approach them, some participants referred to feeling unable to relate to some teachers. Several participants had a perception that the teacher disliked them. In some cases this reaction was clearly very important. For example, Xandra described as 'snobby', those teachers who she felt were difficult to approach and commented that if she liked the teacher she liked the subject they taught.

> If you actually like your teacher, you'll have that thing that I want to learn, the way the teacher teaches you, but if you got a really snobby teacher where it's like that's it, you do this, and you can't approach them. Then it's difficult, but if it's a teacher that you can actually approach and you feel comfortable with and you think yep, they've explained it in a simple way, then I think you'd actually go and approach a teacher a couple of times, thinking I didn't understand it, can you explain it again. But there used to be some teachers at my school and they were like, no, I told you the first time, I told you the second and that's it. So you can't even go and approach them because you're thinking how they are going to react towards it, (Xandra, Interview, 2007).

Xandra added that if she did not like the teacher, she did not like that subject and did not even want to go to school.

> It's like you don't want to study any more. So it really depends on your teacher. If you don't like your teacher, you'll feel really cold towards the actual subject. I'm like that. If I think that my teacher's not good, it's like I don't even want to go to school, or even want to go to that class. Thinking because nothing's sinking in because the teacher's not [teaching], (Xandra).

As previously reported, Kylie and Lucy referred to the intimidation they felt from their science teachers because of the use of sarcasm leading to an inability to approach them when they did not understand a

topic. Also mentioned previously was Annabelle's strong perception that her science teacher did not like her and gave her lower marks because of this. This was in her Year 11 Biology class and Annabelle felt so strongly that she was being treated unfairly that she did not continue with it.

> In Year 11, I did biology and my teacher was really, really nasty, and that's why I didn't follow through, because she'd just…my friend and I she didn't like us and we'd answer the same questions as everyone else yet we'd get a much lower score and … it just wasn't fair. So I didn't continue through with it, (Annabelle, Interview, 2006).

In Yvonne's case, it was so important for her to develop a rapport with her teacher that she chose to do legal studies in preference to science. This is despite the fact that she obviously has a keen interest in science and enjoys science shows on television and often visits Scienceworks. Yvonne made this choice because she liked the legal studies teacher and felt she related well to her whereas the science teacher, who she had encountered earlier in another subject, Yvonne felt she had no rapport with. In response to a question about this, Yvonne replied:

> Um …because I hated the science teacher. That's the only reason why. I didn't like the science teacher back then, so…I'd rather do the legal because I loved the legal studies teacher and I thought she was really fantastic, (Yvonne, Interview, 2007).

However, Yvonne was unable to say why she so strongly disliked the science teacher:

> Oh, because I used to see him around the school. I had him for a couple of other subjects, and we had him as an emergency teacher a couple of times and I didn't, I just didn't clash with him. For some reason back then, if I didn't like my teacher, I would hate the subject. Even if I was very good at it, I would just not want to go to that subject, (Yvonne).

This comment complements that of Xandra reported above and it also indicates how important it is for students to have a positive relationship with their teacher.

Theme 3: Not understanding the work.

The participants described the ways in which they reacted to not being able to get help or not understanding the work. These responses ranged from disengagement and 'switching off,' to active rebellion. Therese's response was the most extreme. She described how when she perceived she was ignored and was unable to get help, she deliberately set out to give her teachers 'grief'. At the time Therese thought it was fun but subsequently has regretted it.

> I'd give them grief in class. I regret it now. I had a good time, it was a lot of fun, but I do regret it, (Therese, Interview, 2007).

When Therese was probed about this statement, she explained her response:

> Because I felt if I wasn't going to get listened to and if I didn't understand what was going on, I might as well have some fun with it. If I'm going to ask a question and it's going to get disregarded, or if I don't understand I'm going to entertain myself in another way. And it just so happened…to rebel,
>
> (Therese).

Therese then started missing classes and eventually was expelled from her school as reported earlier. It is an important story because it details the response of a student who starts off by not understanding the work, but then finds her requests for help are ignored or not answered in a way that helps her understanding. So, initially there is disengagement and then disruptive behaviour and finally truancy. It is important to note that this was a student who was previously happy and successful in school. After her expulsion, Therese attended the local state secondary college which she hated. She discovered that unlike her previous school, no-one noticed if she wasn't there and none of the teachers asked where she was. This had the effect of making Therese think that nobody cared and that she wasn't worth bothering with. Therese then played truant frequently as a result of which she had to repeat Year 11 and subsequently dropped out of school completely. The researcher's impression was that there was a lot of regret and sadness expressed during the telling of her story.

> Um, I hated school. [In reference to Therese's second school] I wagged, a lot. And because of my attendance in the first year I had to repeat Year 11, which I did. But I just ended up dropping out and [thinking] they're not going to chase me for my homework. I just had other things interesting me half the time, (Therese, Interview, 2007).

Annabelle also dealt with her science classes by totally opting out and playing truant from school.

> I discovered I wouldn't get caught…teachers never told me, never said why you weren't in class, (Annabelle, Interview, 2006).

As a result of this, Annabelle developed the perception that nobody cared about her or her progress. Therese's comments on playing truant from school echo those of Annabelle. Both students felt that the teachers were not sufficiently interested in them to follow up on them. Both of these stories illustrate the importance of teachers following up on poor attendance or work not handed in. Both of these participants interpreted the fact that nobody checked on them as an indication that nobody cared about them or had any interest in their progress or their future. Truancy is going one step further than the statement by Xandra reported above where she felt that if she didn't understand, she didn't want to attend that class or even go to school.

Edward tried playing truant but was caught and in his words was in 'real trouble'.

> Well, after a bit, I started skipping his classes but then I got into real trouble.
>
> I had to go to class because they caught me but I was bored and sort of switched off from then and it was no fun, (Edward, Interview, 2006).

Edward dealt with his science classes by 'switching off', a similar technique to that employed by Bertha below. Bertha opted out in a different way. She said that because she didn't understand and was given no help, she 'blocked' it. She then felt she could say it was because she didn't try if she failed. (She did pass her school science but got a 'D' which she regarded as pretty close to a failure).

> I was trying to understand it but I just couldn't and maybe because I couldn't understand it I just blocked everything else out. Like, I was going badly at it and I don't like failing at it, so I just didn't try, (Bertha, Interview, 2006).

When asked what that blocking meant, Bertha explained it as a way of accepting a low grade

> I don't know. I guess because I blocked it out at least if I got the low grade I could say, oh well, I wasn't paying attention and that's why. Like, I wasn't trying or something and that could be the reason why I got the low grade I guess, (Bertha).

Xandra's description of how confused she felt in science makes it very clear why she disliked the subject. Her description of going blank is similar to Bertha's description of 'blocking' everything.

> You just go blank and you look at your book thinking, I don't know what's going on. You've read and read and read and it's like you don't understand anything of what you're reading. It's just, I think it's just the way the teacher like comes in, explains everything does that, does that and then like the bell rings and seconds later the class is finished already. I used to be blank, (Xandra, Interview, 2007).

The researcher was impressed by the sheer grit and determination to succeed that was displayed by these participants. In spite of what was a very unpleasant experience for some of them in their school science, they have persevered and done well. What also came through was the level of disappointment with their school science and how miserable they were in their science classes. They started out keen and interested and were disappointed by the reality. For several of them, that keen interest has been revived in their science classes at TAFE. Annabelle was really traumatized by her science teacher and is still bothered by it. Her description of being 'shut down' by this teacher makes the extent of her experience with this teacher very clear.

> And then of course being shut down like that by the teacher didn't help. Especially that woman: I'd start looking for a job now if I was you. I still cannot get over it. I cannot get over the pressure that's put on young kids to know. Like she was just if you don't do well in year 12 you can go and work in a factory for the rest of your life. The entry score was everything to her and she just didn't want to know about you. And then I asked her for a reference and she just said no. I really would like to see her today and tell her what I've done with myself since Year 12 because she just wrote me off for nothing pretty much, (Annabelle, Interview, 2006).

As a result, of the statements made by this teacher, Annabelle developed the perception that she was not valued or respected. The teacher thought so little of her that she would not even give her a reference and nobody cared whether she attended school or not. This was quite devastating for Annabelle, who blamed herself for her poor progress in science. Annabelle states that she loved science in Year 7 and that it was fun. She then says that she 'sort of lost it'. However Annabelle is an able student. She successfully completed Year 12, in spite of playing truant from school and the suggestion that she should leave school early and get a job and is doing well in her TAFE course. There is also her statement about enjoying science in Year 7. This story raises questions about what happened with the change of teachers from Year 7 to Year 8. An important consideration in Annabelle's story is the lost potential achievement of this student had she not been so traumatized by this particular teacher.

The comments cited above show how important it is for students to feel safe not just physically but also emotionally for optimal development of confidence. They also show how important it is for students to feel they are a valued and respected member of their class at school. The other point that is very clear from the interview transcripts is the importance of a student feeling that they can ask about areas that they don't understand without feeling intimidated or fearful of being humiliated in front of their peers. Constance made it clear that this was a real problem area for her. In reference to her TAFE teacher offering help at her first lesson Constance said:

> Like, in high school you don't feel you can go to the teacher as easily and ask for help, but having someone offer it is a lot easier, (Constance, Interview 2006).

Theme 4: The influence of preferred learning styles.

This reflects the pedagogy used by their science teachers. All the participants were asked whether they were taught by their preferred learning style and, while this was important to most participants, it was not a dominant theme. As previously reported, a number of participants found the 'talk and chalk' method of teaching predominantly employed by their science teachers, both boring and hard to follow. However a far bigger complaint was the inability to obtain help when they didn't understand. Rather than wanting to learn in a particular way.

Surprisingly few of the participants stated that they were hands-on learners. Lucy was one of these and she did the Victorian Certificate of Applied Learning (VCAL) at school. Comparing VCAL with her earlier school experience, Lucy felt that it was more hands on and she found this approach easier.

> I think because it was more hands-on, so I learnt by doing stuff instead of just sitting there and reading and writing and writing it out, (Lucy, Interview, 2007).

Annabelle also preferred a hands-on approach and commented on enjoying food technology at school for this reason. Her comment clearly indicates that her preferred learning style was not met in her science classes:

> And I did like, more hands-on stuff, like food technology. I did really well in that, so I loved it because it's more hands-on. And I did design technology and that was better but then when it came to all the written stuff I just let it go, (Annabelle, Interview, 2006).

Another aspect frequently commented on was how much they liked the diagrams and visual material used by their current TAFE teachers and again this reflects preferred learning styles.

> Um…I like the way [current TAFE teacher] teaches when she does anatomy and physiology, because she uses a lot of diagrams and things like that and, just the way she explains it. And she goes over it a few times to reinforce it and, it's good when you've got, a diagram. And she runs through how it all works, (Daphne, Interview, 2006).

The researcher formed the impression that rather than a different teaching method used, most of the participants would have liked a variety of teaching methods to be used with more opportunity to engage in the topic. For example, Xandra suggested that it would have been helpful to have had the opportunity to discuss topics in class with peers:

> Even if we could, like, sit down as a group from the class and actually do it together. Thinking that the more heads and thoughts you actually have, the easier it'll actually be to sink in. The more people that you have that say things, and everything, then…, (Xandra, Interview, 2007).

Harry would also have liked more variety and had several interesting suggestions:

> …they were very good at what they did, I suppose. Like, they always came to school and they did things, but if I was to teach, I would try and engage the students a bit more and to find out

> where they're at and try and make them feel [involved] in it as well. Even the ones [that are] quiet and not speaking. (Harry, Interview, 2007).

> I think to be aware that you're losing track of them, and to then maybe take them aside later and say look, what is it you're not understanding? What is it I can do to make things easier for you? It might be something really simple. It might be the colour of the pen you're using on the board. It could be anything. So, finding out what it is and then working with that, (Harry).

Harry also spoke about using more colours. He used to watch science programs on television where he liked the way the material was presented:

> …there're lots of bright colours and music and things, (Harry).

Harry also suggested that teachers could use stories and games:

> Like, it is possible to make little games or rhymes. Like, others, like my favorite teachers would have been [telling] stories and things, (Harry).

Harry also made the interesting statement that he didn't know the language and so couldn't read the story.

> [Instead] of reading the story or watching TV where it's all just in a language that I know, like, I have to interpret it, (Harry).

Zara also commented that her mathematics classes were fun because they had some lessons outside and that in English, the teacher read stories and they did some acting out. This again indicates that what the participants found enjoyable and interesting was some variety in the way in which they were taught.

> Well like the maths teacher would smile and we'd go outside and measure things, so it was more interesting and you know why you did it. The English teacher would tell little stories and we acted things from books so that was fun, (Zara, Interview, 2007).

Florence made an interesting statement concerning her preferred way of learning, in which she distinguished between hands-on learning and learning by life experience. For her, a more important aspect is the perception that the teacher is enthusiastic.

> I prefer learning by engagement in life experience. I'm half a visual learner and half auditory. The enthusiasm of the teachers is important. I'm not hands-on and find prac classes less engaging, (Florence, Interview, 2006).

These statements agree with the findings of Lemke, (1990) in which he stresses the importance of science being multi-modal and therefore a multi-modal approach to teaching should be used.
The previous comment by Zara that her mathematics teacher would smile relates to comments reported earlier by Xandra that her teachers were really serious and hardly ever smiled. This also reinforces comments by both Harry and Edward that there was no fun in their science classes. While these statements could be dismissed as excuses by the participants for their poor performances in science, the researcher does not believe this to be the case for the following reasons: firstly, most of the participants who made these comments did pass their school science, although their confidence levels remain low. However having passed, they would not be looking for excuses. Secondly, most participants contrasted their school science classes with other subjects in which they had done well at school and also with their

current TAFE science classes. The points they raised in these comparisons make sense from an educational standpoint.

SECTION 3: Themes expressed by participants who felt confident about their science ability

The Beauty Therapy course which the participants are currently studying at TAFE involves a number of science subjects including Human Anatomy and Physiology, Skin Biology, Cosmetic Chemistry, and Basic Electricity. Most of the participants have commented on the fact that they prefer the way science is taught in these courses to the way science was taught at school. Most participants have stated that they are now enjoying their science and feel that they are understanding it The dominant themes expressed by participants who felt confident about their science, mirrored comments made by other participants about other subjects in which they described doing well at school and enjoying, and also those in their current TAFE science courses. These themes are grouped in the same clusters as those used for the themes in Section 1 of this chapter. These clusters were derived according to whether the identified theme referred to the teaching method used, the perceived attitude of the teacher towards the participant, the perceived responses by the teacher to the students, the relevance of the material taught and the linkage of the theory material to practical work, and the themes are listed according to the clusters to which they have been allocated below. They are then tabulated in Table 6.

Pedagogy:

1. Teacher described as really good
2. Lessons described as interesting and fun
3. Good clear explanations were given with reinforcement from diagrams and visuals

Attitude:

4. Teacher was enthusiastic

Responses to students:

5. Teacher answered questions straightaway

Relevance:

6. Relevance of topics was explained

Table 5: Themes expressed by confident participants tabulated by clusters

	CLUSTERS			
	(A) Pedagogy	**(B) Attitude**	**(C) Responses to Students**	**(D) Relevance**
Themes	(1) Teacher described as really good	(4) Teacher was enthusiastic	(5) Teacher answered questions straightaway	(6) Relevance of topics was explained
Themes	(2) Lessons were interesting and fun			
Themes	(3) Good clear explanations of topics were given with reinforcement from diagrams and visuals			

These themes are important because they represent a contrast to the themes expressed by the participants who did not feel confident about their science.

Cluster A: Pedagogy

Theme 1: Teacher described as really good.

Gillian and Florence were the two oldest participants and they both expressed a high level of confidence in their ability to do science. It is possible that increased maturity has some relevance although both enjoyed their school science and described their science teachers as good. This is the connection that is relevant to building confidence in the ability to succeed in science studies. It is possible that they experienced different teaching methods or by chance had particularly good science teachers. Florence's school science experiences were good and she has maintained a life-long interest in science.

> My school experiences in science were good. The teachers were engaging; therefore I always found science interesting, (Florence, Interview, 2006).

She pursues her interest in science via the internet and the media. Part of the reason she chose to study Beauty Therapy was because it involved some science.

> So the interest was always there, and I pursued it on the internet and in the media, (Florence).

In reply to a question about why she chose Beauty Therapy:

> That science is part of it was important, (Florence).

Since leaving school, Gillian has been working in various medical clinics and offices on the clerical side. She has however always had a strong interest in science and is married to a doctor. Her science experiences at school were very positive although she feels that the nuns who taught her were themselves very limited in what they knew. So that even though her science experience was somewhat limited, the science inquiry approach was used and Gillian's experiences were very positive.

> I've always been interested in how things…or how it works. We got to do experiments and you could actually see it happen. We just weren't exposed to a lot of opportunities, (Gillian, Interview, 2006).

Daphne's comments on her school science experiences contrast with those of most of the other participants as she had a very positive experience starting from primary school. She states that she had very good science teachers which she compares with her mathematics teachers who she says were not very good at explaining things and she really struggled with the subject. Her statement on her mathematics teachers mirrors the statements made by other participants about their science teachers:

> Yeah, for the science subjects, I had really good teachers, (Daphne, Interview, 2006).

> Well, say for example maths, I did really badly in maths in high school. I just, I don't know, whether if I went back now I'd be better but …I just really struggled with it and I don't know…I think had a lot of trouble with teachers in maths. Especially in year 12 we had a teacher that…I don't think she was very good at explaining, and she also wasn't very good at

handling the class and would sometimes just leave and so we'd miss out on hours of time that was supposed to be learning and things like that, (Daphne).

In contrast, Bertha commented on her mathematics teacher being really good compared to her science teacher:

> [In reference to her school science classes] No, not really. It wasn't interesting at all, (Bertha, Interview, 2006).

> My maths was always really good, I was always A+, like my scores were always around 99 or 100% on every maths test I ever had. And that was because the teacher was good and I liked the teacher and … she taught well and if I had any problems she would help me out, like straight away. So I always went really well in that subject because of the teacher, so I think the teacher has a big part to do with it. And the ones that you know aren't there to help you, you can't ask for help so you can't do as well as you possibly could, (Bertha).

Theme 2: Lessons were interesting and fun.

As reported above, both Florence and Gillian described their science classes as interesting. Florence gave as a reason for this that her science teacher was engaging. Gillian described practical classes where she could see how things worked which she found interesting.

> We had a nun for science and while she was good and made the classes interesting, I think she was a bit limited in what she knew herself, (Gillian, Interview, 2006).

As reported earlier, Zara's descriptions of her mathematics and English classes demonstrate that quite simple changes to a teacher's approach can make a big difference to the level of student interest and enjoyment of a topic.

> Well like the maths teacher would smile and we'd go outside and measure things, so it was more interesting and you know why you did it. The English teacher would tell little stories and we acted things from books so that was fun, (Zara, Interview, 2007).

Theme 3: Good clear explanations of topics were given with reinforcement from diagrams and visuals.

Daphne finds the approach used by her TAFE teacher to be helpful with plenty of diagrams and clear explanations.

> I like the way [TAFE teacher] teaches when she does anatomy and physiology, because she uses a lot of diagrams and things like that and, just the way she explains it. She goes over it a few times to reinforce it and, yeah, it's good when you've got, like, a diagram. And she runs through how it all works, (Daphne, Interview, 2006).

What Daphne expressed in the above statement was that she was more engaged with a topic when the teacher appeared to be enjoying it and that it was interesting and fun to have a variety of approaches used. One of the most dominant themes raised by the non-confident group of participants was how boring their science lessons were and how they mainly consisted of copying

notes from the board or from textbooks and even the practical work offered no scope for exploring a topic but consisted of following a precise set of instructions rather than developing an inquiry into the process.

Cluster B: Attitude

Theme 4: Teacher was enthusiastic.

The researcher was struck by the fact that the confident students had clearly enjoyed their school science and very little was said about it that was negative whereas the non-confident students experienced their school science as something to be dreaded and for many of them it represented considerable trauma. Little if anything positive was said in the transcripts. What was perceived as very important to the participants for their interest in a subject was that their teacher was enthusiastic and appeared interested in the subject. Florence's statement reported above that her science teacher was engaging and Zara's comment above that her mathematics teacher would smile contrasts with Xandra's description of her teachers never smiling or making a joke. Harry also commented that the classes he enjoyed were the ones where the teacher told jokes and stories. Kylie's comparison of her science teacher with a check-out salesperson in a supermarket just doing a job and Zara's comment reported earlier that her science teacher came, taught and left and there was no opportunity to ask questions illustrated the perception by these participants that although their science teachers did their job, they were not interested in the subject they taught.

To please her parents, Florence took business studies, a subject which she found boring and which she felt was poorly taught. Her comments on this highlight the importance of relevance and teacher enthusiasm for student engagement in the subject:

> The enthusiasm of the teachers is important. I found business studies boring. I could not connect them with the application. The teacher had no personality and was not fluent in English, (Florence, Interview, 2006).

Cluster C: Responses to Students

Theme 5: Teacher answered questions straightaway.

The participants who expressed a high level of confidence in their ability to do science stated that help was available when they needed it. This statement was echoed by other participants about subjects in which they did well at school and also about the science subjects in their current TAFE courses. As reported on page 70, Gillian stated that she was taught science by a nun who herself was limited in what she knew but still gave interesting lessons. When Gillian was asked what her teacher did to make the classes interesting, she replied that her teacher explained when they asked questions:

> Well, she was strict in that we had to do our work, but she explained when we asked questions and we had really interesting experiments and I enjoyed that, (Gillian, Interview, 2006).

One of the most dominant factors raised by the non-confident participants was their inability to get help when they needed it or to have their questions answered. In many cases, the participants

reported an inability to ask questions because of a perceived fear that they would be treated in a way that made them look stupid or be laughed at by their peers. As previously reported, Constance commented about her TAFE classes that it made a big difference to her to feel she can ask questions when she doesn't understand:

> Like, in high school you don't feel you can go to the teacher as easily and ask for help, but having someone offer it is a lot easier, (Constance, Interview, 2006).

Bertha's statement reported earlier that her mathematics teacher always helped her straightaway was what Bertha felt gave her confidence in her mathematical ability.

Cluster D: Relevance

Theme 6: Relevance of topics was explained.

Another important aspect that was frequently commented on was the relevance of the material being studied. The example given by Bertha, reported earlier in regard to chicken breasts shows very clearly how important this is. Bertha also commented in relation to her school mathematics (in which she did well), that the teacher always showed the relevance of what they were doing. In addition, Bertha commented that she can see the relevance of her current science courses

> So this kind of science that we're doing in beauty therapy I can relate to my everyday life that's why I'm interested in it and am doing well in it now, (Bertha, Interview, 2006).

This comment makes it clear that the relevance of the topic is very important both for maintaining interest and for clearer understanding.

Gillian commented on the fact she had a lay teacher for geography who introduced them to more life experiences which was valuable for her.

> We had a lay teacher for geography, it introduced a lot more life experience type lessons, which I think were more valuable to us, and we'd get out there in the field, you know, when we were looking at fossils or what we were doing, it would be very much hands on, (Gillian, Interview, 2006).

SECTION 4: Other influences

This section reports on other areas that were probed during the interviews. These included the influence of peers, and gender or cultural issues. There were no consistent or dominant themes that emerged from these areas but the researcher considered it to be important to probe them as there are many literature reports suggesting that science studies may be influenced by these areas, (TIMSS reports, 2003, 2007; Sadker and Sadker, 1985; Irvine, 1990; Jackson and Costa, 1974).

Influence of peers

Statements by the participants indicated that they were aware of different groups within their schools. However, participants in the current study were adamant that they were not influenced by peers or concerned with appearing 'cool'. Therese, for example, stated that while people were

grouped and labeled in the second school she attended, there was no pressure to conform to a particular group:

> And people were given titles and groups, and there were the nerds, and there were the basket-ballers, and there were, you know, the drug addicts and the goths and that sort of thing, but it was each to their own. There was no fighting between groups, there was no get out of my face you do science, I do whatever. I've never seen that, I've never been a part of it, I've never practiced that, and I think it's a really sad thing to do, (Therese, Interview, 2007).

However there were some statements suggesting that peer pressure was relevant for some people if not for participants in this study. Daphne when interviewed was one of the older participants being in the 25-35 age-bracket although considerably younger than Gillian and Florence and in response to a question about gender pressures at school:

> I was with a couple of girls who weren't considered popular, so we didn't really care. We just did what we wanted to do, whereas others probably didn't do it because it wasn't considered to be, you know, the cool thing to do, (Daphne, Interview, 2006).

These comments do suggest that there was some level of peer pressure among the school students towards science and that the participants were well aware of this, or possibly this related to being seen as 'cool'. For some of the participants, science was not seen as being a 'cool' subject although most denied that this was important. Bertha made a reference to associating science with 'nerdy' types of student.

> Before I thought it was boring and only for the nerdy kind of people, (Bertha, Interview, 2006).

Kylie suggested that peer pressure had some influence on her but not to the extent where it affected her studies in any way.

Influence of gender

Most of the participants were emphatic that gender did not influence their science studies in any way. The two participants in the current study who did however feel that gender had an impact were both mature aged which suggests that this may be a less important issue than it has been in the past. Florence is a mature aged student (45 plus), who rated her ability to do science highly. She had positive school experiences in science and expressed a keen interest in it. She experienced gender bias from her parents who saw her brothers' education as being more important and science as a subject for males. Despite this, Florence did still study science at school but was prevented from continuing beyond Year 10 with it. The pressure came from her parents rather than from her school. Her parents saw her brothers' education as being more important than hers as they expected her to get married.

> I wanted to do science but my parents said it was for males.
>
> My brothers [older] did sciences. They helped with maths homework, but I didn't need help for science. My brothers' education was more important than for girls, as far as my parents were concerned, (Florence, Interview, 2006).

Gillian, like Florence, is a mature-aged student of 50 plus. As reported on page 50, after she completed Year 10 at school (which was a Catholic girls' school), her school amalgamated with a boy's school. Following the amalgamation, Gillian felt that she experienced gender bias for the remainder of her schooling. Her statement on this was that the girls just got lost. At home, Gillian described her father as domineering. He blocked Gillian from her chosen profession of nursing. Gillian felt that her wishes/aspirations were not heard or were discounted by her father who believed her education was unimportant as she would get married.

> At school at the time we only had commercial or academic ...and so they looked upon us. Our academic ability in terms of which way we were to go… a woman was looked on by my father particularly, not necessarily my mum, but my father was like she'll get married and so I left school, and then I went and did a night class for commercial and learned to type and worked in an office, (Gillian, Interview, 2006).

Gillian however, maintained her interest in science and medicine and ensured that her office jobs were in the science or medical area. Florence who is about fifteen years younger than Gillian also encountered the attitude that she should do business studies rather than science because science did not lead to jobs for women. However none of the younger participants reported this sort of bias from their parents. The researcher herself had a similar reaction to Gillian and Florence from her father who believed that the education of her brothers was more important and that she would just be getting married.

Harry experienced gender bias in a different sense in that his stepfather pressured him to study in ways he did not want to ensure that he got a good job.

> My stepfather… made me in some way that I did not want to study so that I would have a good job, (Harry, Interview, 2007).

Although she has a very positive attitude towards science, Daphne feels that it is a subject for males but because she had a group of like-minded friends, they were able to discount the group attitudes and study science.

> I think it's just you don't really expect many females to be interested in science. It seems to be more a male dominated area I think, (Daphne, Interview, 2006).

Summary

In summary, there are many ways in which the science education of many of the participants was inadequate. Most of the participants started school with a high level of interest in science and their initial experiences were positive. They then encountered a particular teacher who they perceived as affecting their confidence in their ability to succeed in science. The relevant themes identified relate clearly to teacher attitude and style of teaching. There may be subtle gender influences such as those described by Johnson, 2007, who has identified ways in which coloured women in America may be discouraged from taking up science careers by science professors.

The following chapter –Discussion, discusses the implications of these findings and relates them to the literature and to the research questions.

CHAPTER 6: DISCUSSION AND CONCLUSIONS

Introduction

This chapter links the themes extracted in Chapter 5 with the research questions and discusses the implications of the findings. The research questions (which are listed below), will be discussed in sequence including relevant research reported in the literature. The validation of the research is then discussed. This is followed by a consideration of the implications of the results with recommendations for future science teaching.

The research is a narrative in that it aimed to get the stories of the participants in their own words of their science experiences. Bruner, (1985), stated that the narrative is the way in which children organize and understand their world. By collecting these science stories, the aim was to see which influences were important in determining the participants' attitudes towards science.

The most important finding of the research that focused on this group of Beauty Therapy students was the critical importance of the teacher-student relationship. The research also identified a need for teachers to develop multimodal forms of presentation and ensure that explanations are clear. The material studied needs to be relevant so that students can see the need for them to study it. The non-confident participants described teaching practices in their science classes that have been known for many years to be poor. However most of the participants in the current study are under 25 and so these shortfalls are recent and current practice. Moreover the two oldest participants in the study described better experiences in their school science than the younger participants.

SECTION 1: The research questions

The researcher taught a variety of science subjects to Beauty Therapy students for eight years. During this time, she observed that most of her Beauty Therapy students lacked confidence in their ability to succeed in passing these science units although they did in fact pass. They commenced their Beauty Therapy science courses with this poor confidence in spite of having successfully passed their secondary school science. 'Science anxiety' is a term coined by Mallow, (1978), to describe the phenomenon of a person experiencing extreme anxiety and a fear of failure when required to do science in any form. This anxiety was evident even in people who had successfully completed science courses. They continued to feel anxious with a lack of confidence in their ability to use their knowledge. Many of the Beauty Therapy students exhibited science anxiety as defined by Mallow and most lacked confidence. Significantly some of the participants described liking science outside of school. This correlates with findings by Lindahl, (2003) on Swedish students. The researcher also taught science to a range of other students ranging from science and medical students at Monash University and other TAFE students such as trainee laboratory technicians and did not observe science anxiety or lack of confidence in science ability in these other groups of students. The researcher was curious about this difference in confidence. This was the background that led to the research questions which are listed below:

1. What experiences in learning have contributed to the development of poor confidence in the ability to do science and to low levels of scientific literacy in a group of Beauty Therapy students?

2. What other experiences may have contributed to the low levels of scientific awareness and confidence displayed by these Beauty Therapy students?

3. Which of these factors are common to the group as a whole?

Research Question 1

What experiences in learning have contributed to the development of poor confidence in the ability to do science and to low levels of scientific literacy in a group of Beauty Therapy students?

For the participants in the current study, the results presented in the previous chapter show a strong connection between the perceptions of the participants towards science and their school experiences in science. Those participants who described poor experiences in their school science classes developed a progressive lack of confidence in their ability to succeed in science studies and also regarded science as a subject which was too difficult for them. These participants ascribed their lack of confidence to one particular teacher usually in early secondary school citing teacher attitude towards them and teaching methods employed as causal factors. It is stressed that the researcher is aware that the data reported in the previous chapter is based on the perceptions of the participants and may not accurately reflect teaching practice. However there are sufficient points of similarity between the participants' stories to raise concerns about practices which may be occurring in science teaching and it is important to look at the underlying causes. It is also important that the participants have strongly linked their low levels of confidence in science to particular teaching practices.

The possibility that participants were using poor teaching as an excuse for their own performance in science was considered. The researcher discounted this for several reasons. Firstly, although they did not feel confident about their science ability, these participants did pass their school science and so did not need an excuse for poor performance. Secondly, many of the participants blamed themselves for not working properly (Bertha, Annabelle, Harry), or said that they were lazy or immature (Annabelle, Xandra). Thirdly, it was noted by the researcher that the participants showed disappointment with their school science and had enjoyed it until they had a particular teacher. Fourthly, some participants were obviously distressed by the memory of their school science especially Annabelle Constance and Therese. Finally a number of the participants were actively frightened of or felt intimidated by their science teachers when they were at school (Constance, Lucy, and Kylie).

It was apparent to the researcher that for many of the participants, the memories of their school science experiences evoked distress and regret and several (Constance, Annabelle, Bertha, and Edward), dreaded going to their science classes. Of the fifteen participants, only three rated their ability to pass their current TAFE science courses as higher than five out of ten. This is despite having successfully passed their school science. The twelve participants with low levels of confidence in their science ability described enjoying science classes until they had a particular teacher in secondary school.

A very serious area of concern is the number of participants who perceived their teacher as not respecting them. It is important for a teacher to show respect towards their students especially during the teenage years when self confidence is built (Erikson, 1963). Erikson, in his theory of

Psycho-Social Crises noted the necessity of a nurturing adult to assist a child to move through the different stages of development. Very frequently, for children, this mentoring role is taken by their teachers so for those participants who experienced their science teacher's remarks as derogatory or humiliating, this mentoring role was not fulfilled. Those participants who received this type of response from their science teacher developed the concepts that they were stupid or inadequate and unable to succeed at science. A further response was disengagement eventually leading to truancy and in one case (Therese), active rebellion which caused the expulsion of the participant from her school– a fact she deeply regretted later. Therese stated that nobody noticed or cared if she was not in class so that she did not feel valued or respected. For development of confidence and motivation to progress further, the child needs to feel valued and respected, both by their peers and by their teachers. Importantly in the context of development they also need to value themselves and see themselves as worthwhile and able before they can move to the next stage of developing their potential, (Maslow, 1943).

It is recognised that children need to feel safe within the school environment, (Maslow, 1943). While this aspect is more often applied to instances of bullying, it is also relevant where a teacher uses intimidatory behaviour. Three participants expressed fear of their science teacher while at school and several others described their teachers as intimidating and unapproachable. For these participants, the learning environment of their school science classes was neither supportive nor productive, (The first PoLT principle, 2001).

Maslow, (1943) also identified the need for children to feel they belong in a group for optimal progress. The child who does not have safety or belonging needs met will be reluctant to come to school. These basic needs – that of belonging and respect were not met for many of the participants in the current study. Edward, Therese and Annabelle all described instances of missing classes because they were so uncomfortable in their science classes. Xandra stated that she didn't even want to come to school when she disliked her teacher. Constance, Kylie and Lucy were frightened of their science teachers while at school and dreaded every science lesson. Several participants reported that their science teachers, in many cases, responded to questions by actively belittling the participant or other members of the class who asked questions. The result of this was that the participant would not risk asking further questions because of their fear of being humiliated in front of their peers. This fear was based on immediate personal experience or observed practice by their teacher. A high percentage of the participants stated that this was a problem for them, and it is important to look at possible underlying causes of this teacher behaviou and also to look at ways to improve it. The participants cited above felt that they were not valued or cared for by their teachers and this inevitably reflected on their self esteem.

As mentioned above, in a few cases actual fear of the teacher was expressed while one participant (Kylie) was fearful of the possibility of being in trouble if she asked questions. Lederman, (1992) noted that a positive relationship between student and instructor was an important determinant of student success in a subject. Inevitably as several participants reported, where they did not like the teacher or feel that they were valued, it affected their attitude towards the subject. Haladyna and Shaughnessy, (1982) reported that there was a consistent relationship between student attitude and achievement with a positive attitude leading to high achievement.

Another problem identified in the current study was that either the participants' school science teachers did not provide explanations or when they did, they were not clear. One relevant aspect to

explanations being perceived as poor or inadequate, concerns the ways in which explanations were given. Harry, for instance, complained that he did not know the 'language' (of science) and that he could not 'read the story.' This statement was interpreted by the researcher to mean that Harry could not follow the explanations he was given because he did not understand the language used in these explanations or was not made aware of the meanings of the scientific terminology. As discussed in the literature review, there are two aspects to scientific literacy - one is the scientific terms in themselves which may not be clearly defined by teachers. The other aspect is the non-technical language used by the teacher which is an area the teacher is often unaware of. Oyoo, (2005).

Although science is a practical subject, the explanations and teaching surrounding this is a discourse. This means that in order to achieve success in science, a high level of general literacy is necessary. Some students, such as those in the current study may lack this background and hence find themselves struggling without understanding why. Several participants spoke of being overwhelmed with writing and reading combined with lecturing from their science teacher. These participants spoke of becoming lost and switching off. This suggests that for these participants, they were already feeling that science was too difficult for them. Lyons, (2006) reports similar statements from his research. Lindahl, (2003b) found that even high achieving students who had intended to pursue careers in science eventually found it so boring that they gave it up.

Edwards and Mercer, (1987) have shown that during approximately two thirds of classroom time someone is talking and mostly this is the teacher. Edwards and Mercer's study was carried out across all disciplines, and they also showed that most teacher talk was either lecturing or asking questions. For non-auditory learners, this could impose considerable difficulty in assimilation and understanding of the material. Difficulty in understanding can also lead to a perception that the teacher is going too fast. Bertha, in particular found this a problem, and, although she asked her teacher on a number of occasions to slow down or to explain further, she felt ignored.

There was constant reference by the participants to the inability to obtain help or have questions answered. There may be valid reasons for not answering questions during the middle of a theory session; in this case, time should be made available at an alternative time when questions could be answered. Ten of the twelve non-confident participants expressed a strong perception that they could not ask questions if they did not understand or if they did ask, that the question would not be properly answered and in Kylie's case, she thought she would get into trouble if she asked questions. It is noted that this was her perception at the time and she now recognises that she would not actually have got into trouble had she asked questions. However at the time, Kylie perceived her teacher's manner as so intimidating that she thought she was not allowed to ask questions. Participants noted that in their current TAFE courses, they are encouraged to ask questions when they do not understand a topic and that this was helpful both to their understanding and their confidence levels. In many of these cases, participants were discouraged from asking questions by the use of comments by their teacher which were perceived as sarcastic or demeaning. In other cases, no opportunity was made available to ask questions either during or after class. Participants also described being told by their teacher to find the answers to their questions by reading notes or textbooks.

Perceived intimidatory behaviour by teachers is not a recent phenomenon. Briggs, (1928, p. 685), in an article on sarcasm, noted that pupils considered that 'the user of sarcasm intends to be mean,

bitter, stinging, scornful, contemptuous, spiteful, that he is unsympathetic and sneering, taking advantage of his position or training to inflict punishment and pain by belittling a pupil with intent to hurt.' Briggs also noted that these are the students' perceptions and that few teachers have any of these intentions and that what they may intend as a witticism/criticism or even pleasantry is often understood by students as sarcasm. Of the participants in the current study, Harry noted that the purpose of ridiculing him was an attempt to make him pay attention.

Several participants stated that when they asked questions, they were ignored or answered in a way that was not helpful. The first two SIS, guidelines (Goodrum et al, 2001), state that:

- Students are encouraged to actively engage with ideas and evidence
- Students are challenged to develop meaningful understandings

If participants felt unable to ask questions, then it would be more difficult to develop meaningful understandings of their science topics. In an environment where questions were discouraged, participants were not encouraged to actively engage in ideas and evidence. For these participants, the SIS guidelines above were not followed. For most participants, the effect of being unable to obtain help when they needed it led to disengagement and falling behind with their work which amplified the perception that science was too difficult for these participants. As reported earlier, the disengagement and perceived lack of respect by their science teacher led to truancy in three of the fifteen cases studied. Two of these participants stated that no-one noticed if they were not in class. This led these two participants to feel that no-one cared about them or valued them.

In this context, Penso, (2002, p. 34), noted that student teachers tended to ascribe learning difficulties to students rather than their teaching: '…if only they (their students) would listen, they would understand.' This attitude by a teacher could lead to the sorts of treatment that the participants described when they asked questions. For many of the participants in the current study, there seems to have been little awareness by their teachers of the fact that the student in question was in need of help. Attempts made by the student to seek this help were rebuffed or ignored. This is important because many aspects of science are consecutive; that is, it is necessary to understand the earlier work before proceeding further into the topic. So for those participants who could not obtain help when they needed it, they had increasing difficulty with subsequent work.

Most participants stated that theory presentation in their school science classes was boring and consisted largely of copying notes from the board or reading textbooks. Few explanations, visuals or diagrams were provided. Even those participants whose school science experiences were positive commented that they preferred the approach used in their current TAFE course where a lot of diagrams and visuals are used and clear explanations given. Several participants commented on the fact that there was no help given to become scientifically literate (by Harry directly and by Bertha and Xandra indirectly). This made it difficult to follow and understand board and textbook notes. Participants described feeling overwhelmed by the sheer volume of writing and of trying to keep up with board notes as well as what was being said. This also correlates with the study by Osborne and Collins which reports similar comments from British students about their school science, (Osborne and Collins 2001). For many of the participants, the constant writing and lack of variety in their science lessons led to disinterest and boredom. This was enhanced by their inability to clarify points that they did not understand because their science teachers discouraged questions directly or indirectly.

Osborne and Collins, (2001, p. 450) attribute the large amount of note-taking to an overfull curriculum where students are 'frog-marched across the scientific landscape, from one feature to another, with no time to stand and stare, and absorb what it was they had just learned.' Another aspect of this is the necessity to cover large amounts of material in shortened times due to pressure from other areas of the curriculum.

One very significant area is the qualifications of secondary science teachers in Australia which in turn can influence teacher behaviour patterns as described by Smith, (1990). Smith investigated the effects of teacher knowledge on pedagogy and found that when teachers were inadequately qualified in either content knowledge or the pedagogy of their subject, they relied heavily on notes and textbooks. Koehler and Grouws, (1992) also stated that teachers' behaviour is influenced by their content knowledge, their knowledge/understanding of pedagogy and their knowledge of teaching methods specific to their subject. A study carried out by the Centre for the Study of Higher Education at the University of Melbourne, (Harris, Jensz and Baldwin, 2005) found that many science teachers in Australia are inadequately qualified in one area or the other. In reference to mathematics teaching, Ernest, (1989), noted that teachers' attitudes towards content includes their enjoyment/liking/interest in the subject and their confidence in their own abilities together with how highly they value the subject they teach and that these beliefs or attitudes will affect the children they teach.

Abrahams, (2009) carried out a study of around five thousand British school children in a group of English comprehensive (non-selective) schools. Abrahams' aim was to study the extent to which practical work influenced children's decisions on whether to continue with post-compulsory science. He found that practical work had an effect on short term engagement but not on long term goals. Abrahams reported that the children when questioned about doing practical work said that it was less boring than writing, and better than reading textbooks. They also said it was less boring than listening to their teachers. These comments reflect many of the issues raised by the participants in the current study. Namely that their science classes largely consisted of copying notes from the board or a textbook while their teacher lectured and that while their practical work was fun, it did not have much relevance to them.

Most of the participants stated that they enjoyed doing their practical work but had difficulty understanding its purpose as there was often a poor link between theory and practical which were sometimes several weeks apart. They also described their practical work as following a list of instructions rather than as an inquiry into a topic. This point would make it more difficult to make the link between the practical work and the theory. Another point made about the teaching was that the relevance of what they were learning in school was not explained to them and there was little or no link with their own life experience. This lack of relevance led to confusion for some participants as they were not able to relate the work being studied in a meaningful way to their own lives. This also conflicts with both the SIS guidelines and with the Principles of Learning and Teaching (PoLT).

The level of enthusiasm shown by teachers towards their subject was seen as very important. Several participants stated that their science teachers did not seem interested in their subject or enthusiastic about teaching it - participants clearly found it difficult to maintain interest in a subject in which their teacher was perceived as being uninterested. As one participant pointed out, how can you feel interested in a subject if even the teacher is not interested? Most participants described

their science classes as not enjoyable or fun and their science teachers as very serious and not smiling or making jokes.

A study carried out by Appleton (1995) used surveys of pre-service teachers, pre and post a science education unit. Comments from his study mirror the type of comment made by participants with regard to their current TAFE science courses or for other subjects in which they did well at school. Some of these comments are repeated below:

> I thoroughly enjoyed the science, [in the science education unit], which came as a surprise for me. I have always felt intimidated by the content and the knowledge. [The lecturer] made me and the rest of the group [of students], feel comfortable with it, (Appleton, 1995, p.365).

> During school, science was all information and writing. Science was laborious and boring. That one afternoon a week called "science" imprinted bad attitudes not only on me but also on my fellow classmates, towards science. What a relief it was to discover that this subject was not all facts and figures but actually fun, not to mention interesting, (Appleton, 1995, p.365).

Moreover, Appleton reported on his students' perceptions of science teaching, and their comments are closely related to those of participants in the current study:

> I thought [teaching science] was mainly standing out in front teaching kids out of a textbook more or less, (Appleton, 1995, p.363).

> Among the participants in the current study, Harry gave a similar description of his science teacher:

> Like most [science] teachers kind of read from a text book, (Harry, Interview, 2007)

As reported earlier, most participants described their school science classes as boring and Appleton's students made similar comments:

> I thought science was, like a boring subject, (Appleton, 1995, p.363).

Excerpts from Appleton's interviews correlate well with the experiences described by participants in the current study suggesting strongly that low confidence levels together with a lack of interest in science studies relate to the ways in which science was taught in secondary schools.

Lyons, (2006) compared students' experiences of school science in Sweden, England and Australia based on studies by Lindahl, (2003b), in Sweden, Osborne and Collins (2000, 2001) in England and his own research in Australia, (Lyons, 2003). His findings showed that the students in the three countries reported very similar findings namely that school science was presented with a boring transmissive pedagogy, decontextualised and unnecessarily difficult. These were all identified by the participants in the current study as being pertinent to the formation of their attitudes towards science. Lyons also noted that the students in the studies he compared complained that the excessive writing and note-taking was frustrating because they couldn't read the information given and understand it as they were writing and copying and they described being lost. This is also similar to views expressed by participants in the current study.

The opposite story was told by those participants who felt confident about their science. They spoke of good teachers, fun lessons, and clear explanations. Similar statements were made by most participants concerning the science teaching in their current TAFE courses. Statements made by the participants about other subjects in which they did well at school corroborated the statements of the confident participants. The way in which their school science was taught was perceived by most participants as the dominant reason for their lack of confidence in science.

In summarising, the research shows that lack of confidence in the ability to succeed in science studies is strongly related to the science teachers in the secondary school. Confidence is affected when the teacher does not display respect for the student. It is also very important that teachers are willing to spend time assisting students to ask about points they don't understand.

Confidence is also affected by the relevance of the material being studied being clear to the student. The relevance also helps in the development of interest in a subject. Interest in a subject is important in the development of scientific literacy as it leads to further exploration of the subject by the student. Interest in a subject is higher when the student feels engaged. It is necessary that the teachers themselves appear enthusiastic and interested in their subject. The other aspect of importance in developing scientific literacy is the explanation of terms used in ways that the student understands. The importance of 'hands on' pedagogy is emphasised but it is also seen as more important to use a variety of approaches with clear visuals and diagrams and telling the 'story'. Xandra suggested it would have been helpful to her to discuss topics with her fellow students. This would be an application of Social Constructivist Theory, (Vygotsky, 1978).

Lack of modern equipment was another factor mentioned which was seen as important. Although several participants spoke of poor discipline in their science classes, this was not seen as a factor that affected their confidence but as a limitation on what the teacher could do. Kylie saw it as a factor that affected her ability to concentrate and commented on her science teacher continuing to talk even when students were throwing things. Most participants perceived their science teachers as very serious and would have liked to see them smile and occasionally make a joke or tell a story to introduce more fun into their science classes.

It is an important point that the negative attitudes towards science were not carried over into their schooling generally. Most of the participants mentioned other subjects in which they had done well at school and crucially that they had good relationships with the teachers involved. This agrees with research by Morrell and Lederman, (1998) who suggest that while student attitudes towards school are generally positive, their attitudes towards science are not.

Research Question 2

What other experiences may have contributed to the low levels of scientific awareness and confidence displayed by these Beauty Therapy students?

This section discusses the other experiences of the participants in the study and the effects of these experiences on the development of their attitudes towards science. There is a discussion of student related themes which arose as a consequence of the teacher related themes as the participants described these themes as responses to the teacher-related themes. The researcher sees these themes as the beginnings of the loss of confidence in their ability to do science. Other influences that are discussed in this section are gender issues, cultural background and peer pressure. These

were all areas that were probed during the interviews, although most of the participants stated that these were not important to them.

1. Student related themes

There were four main themes that were classed as student-related. These themes are listed below:

a. Self blame

b. Relationship to teacher

c. Not understanding the work

d. The influence of preferred learning styles

The participants who described these themes are listed in Table 4 on page 72

These student-related themes represent the beginning of the loss of confidence in the ability to do science. They arose as a consequence of the teacher-related themes. For example, in connection with some microscope work, Bertha said she did not work properly but this followed on not being shown what to do or not in a way that made sense to her. Therese stated that if she could not get her questions answered and if she was not going to understand it, then she would have some fun and she deliberately set out to disrupt the class. Importantly this did not happen until Therese developed the perception that she was not going to be able to get her questions answered. Similarly, Annabelle developed the idea that her teacher disliked her and treated her unfairly as a consequence. This perception arose because Annabelle stated that she and her friend were given lower marks than the other students even when they gave the same answers. It is noted here that the researcher believes this to be unlikely and that the probable situation was that Annabelle misunderstood the required answers. However if this was the case, her teacher should have clarified what the problem was.

While most participants agreed that they were not taught by their preferred learning style this information was not volunteered until they were probed about it during the interview. Only one participant, (Lucy) stated that it was a major problem. This factor relates directly to the pedagogy employed by their science teachers. As stated earlier, rather than being taught specifically to cater to their preferred learning style, most participants would have liked more variety and interest in the pedagogies employed by their science teachers. They would also have liked more visuals and clearer explanations.

2. Influence of gender

Gender issues were probed in the interviews, but did not appear to have a major influence. However because there is a considerable volume of research on gender influences on opportunities and level of interest in science, this area was explored in some detail. The TIMSS reports (2003, 2007) noted that the attitudes of girls towards science and access to science subjects was more limited than that of boys, although other factors such as level of parent education, might outweigh these differences.

With the exception of the two oldest participants, participants in the current study stated that gender had no influence on their science experiences. There may however have been an indirect gender effect due to differing attitudes displayed by teachers towards male and female students but

no data was evident in the transcripts about this. However, as reported in the literature review, a number of studies (Sadker and Sadker, 1985; Irvine, 1991; Jackson and Costa, 1974), have shown that teachers devote more of their attention to male students in a class than to female students. Irvine also noted that this particularly applied to white males. A review by Rennie, Fraser and Treagust, (1999) suggested that gender may have an indirect influence on teaching, stemming from teacher attitudes and beliefs. If, for example, a teacher has the belief that females cannot do science, inevitably, this teacher will spend less time and persevere less with female students than with males in a mixed class. This might account for the difficulty that some participants in the current study experienced in getting satisfactory answers to questions, although not aware of being discriminated against for gender reasons. Rennie et al also suggested that some teacher's expectations of students' behaviour in class and teacher–student relationships were sex–based in many instances. Some statements made by participants in relation to male science teachers corroborate the observation that teachers respond differently to male and female students. Constance did state that her science teacher (who was female), made the girls sit at the back of the class. The reason for this was not clear.

There were some minor gender issues with a few of the participants but they were not of a nature that impacted on their confidence levels in science. There was no suggestion made for example, that girls were unable to succeed in science because they were female. It was more a question of science not leading to employment for females. Only one of the participants (and she is a mature aged one), encountered gender bias at school but this was at a general level and not specifically related to science.

3. Cultural background

The participants in the current study all attended urban schools and none are of aboriginal origin. As noted in Table 1 on page 41, all participants except Lucy and Florence were born in Australia. Lucy and Florence were both born in the United Kingdom, but arrived in Australia at a very young age. All participants were educated in Victorian schools aside from Xandra and Yvonne who each spent a year in a Turkish school. The parents of the participants came from a range of different cultural backgrounds including Australian, Dutch, English, Maltese and Turkish. Aside from one of the older participants, (Florence), most were adamant that their parents had no influence on their choices and did not object in any way to them studying science and even for that one participant, her parents did allow her to study science up to Year 10. Florence's parents had the view that science studies did not lead to jobs for women rather than an objection on cultural grounds. One of the male participants observed that his stepfather put him under pressure to do well at school, but that this was from a concern that he would get a good job.

4. Peer Pressure

The researcher had expected that the participants would be influenced by dominant peer groups within their schools, so this possibility was probed in the interviews. Although statements were made indicating that participants were aware of groups within their schools, they were adamant that this did not influence them. There were references to people who took science as 'nerds' and that it was seen as 'cool' or not cool to belong to certain groups. However participants stated that they did not feel pressured into doing things to appear 'cool'. This correlates with research by Lightfoot, (1992), who stated that although most adolescents are subjected to peer group pressures,

they report that they do not experience this as a major influence or something they find difficult to handle. Kylie stated that she was influenced to some degree by her friends but that it made no difference to her subject choices.

Research Question 3

Which of these factors are common to the group as a whole?

As described earlier, of the fifteen participants, twelve expressed a lack of confidence in their ability to succeed in the science components of their current TAFE courses. The research has identified a number of themes which are important in the development of poor confidence in the ability to succeed in science studies. The derived themes were divided into two groups – teacher related and student related. The student related themes arose as a consequence of the teacher related themes and the researcher feels they represent a stage in the development of poor confidence in science ability. The aim behind research question three is to see how many of the participants in the current research experienced each of the identified factors or themes. This provides a picture of the complex of factors or themes which lead to poor confidence in the ability to succeed in science.

During the interviews, participants were asked about their school science experience. From the participants responses, twelve themes were identified which related to the participants' science teachers. It is stressed that the themes are based on the participants' perceptions and recollections of their experiences of their school science teachers and classes. Some of these themes derive from the pedagogies used by the participants' science teachers. Others are concerned with the relationship of the participant to their science teacher. The manner of the teacher was also perceived by the participants as being very important. The themes or factors identified as teacher-related have been summarised from the perceptions reported by participants of their science teachers. These summary points are listed below:

1. Students expected to learn from board notes or textbooks
2. Limited or poor explanations given with practical work – students effectively just following a set of instructions with no opportunity to explore or create inquiry questions
3. Boring presentation
4. Poor discipline
5. Lack of respect demonstrated by teacher for their students which included 'put-downs' and in some cases perceived intimidation of students by teacher
6. Impression given by teacher that science is difficult and complex and beyond the abilities of a particular student
7. Unfair treatment
8. Lack of enthusiasm by teacher for the subject being taught
9. An unwillingness to answer questions
10. No help given even after repeated requests

11. Lack of relevance to student or relevance not explained

12. Poor connection between theory and practical work

Research Question 3 asks which of these themes were common to the group as a whole. There were no themes common to all participants but from Table 3 on page 59, it can be seen that Themes 1, 3 and 9 were each experienced by ten of the fifteen participants. This represents 84% of the non-confident participants. These themes are:

- Students expected to learn from board notes or textbooks (1)
- Boring presentation (3)
- An unwillingness to answer questions (9)

These themes relate directly to the pedagogy employed by the participants' science teachers. Themes 2, 11 and 12 also relate to the pedagogy employed by the participants' science teachers and were experienced by five of the non-confident participants. These themes are:

- Limited or poor explanations given with practical work – students effectively just following a set of instructions with no opportunity to explore or create inquiry questions (2)
- Lack of relevance to student or relevance not explained (11).
- Poor connection between theory and practical work (12).

Two other themes (themes 5 and 10) were also common to a majority of the non-confident participants (58%). These themes which are listed below, relate to the perceived relationships of the participants to their science teachers.

- Lack of respect demonstrated by the teacher for their students which included 'put downs' and in some cases perceived intimidation by the teacher (5).
- No help given even after repeated requests (10),

Theme 5 involved the strong perception by participants that their science teachers did not value them or care about them. Perceived intimidation by the teacher made it difficult for participants to approach their teachers or request help when they needed it. This impression was strengthened by Theme 10, when participants found they were unable to get help from their science teachers even after repeated requests. Theme 10 is closely related to Theme 9. In both cases there was a perception by the participants that they could not get help when they needed it or that their science teacher was unwilling to make time available to help them.

A further two themes (6, 8) were common to five of the twelve non-confident participants. These themes are listed below:

- Impression given by teacher that science is difficult and complex and beyond the abilities of a particular student (6).
- Lack of enthusiasm by teacher for the subject being taught (8).

Theme 6 relates to the perceived relationship of the teacher to the student and as with Theme 5, it led to a perception that the participant was not valued by their science teacher.

The lack of enthusiasm by the teacher for their subject was seen as very important (Theme 8). The participants describing this stated that it was difficult to develop an interest in a subject if even the teacher was not interested

The remaining two themes (4 and 7), each had three participants in common

- Poor discipline (4).
- Unfair treatment (7).

With Theme 4, Kylie described classes where students were throwing things and talking while her teacher continued to lecture without imposing any discipline. Theme 7 again concerns the student/ teacher relationship. In these instances, the participants developed the perception that they were unfairly treated because the teacher disliked them or did not respect them.

While there was no single dominant theme, the results of the study give a picture of the participants' school science classes as boring sessions with large amounts of note-taking from the board, text books and lectures. Little or no help was available and the relevance of topics was not made clear. While practical work was better, there was no opportunity to develop inquiries into topics and the relationship to the theory was poorly explained. In some cases this was combined with a perceived lack of respect by the teacher for the student and in others, the class discipline was poor. It is stressed that these results were derived from the perceptions of the participants. However the fact that these themes were experienced by most of the participants does suggest that this is an accurate picture of their school science experiences.

This contrasts strongly with the experiences of the confident students. They spoke of enjoying science classes, and of having interesting experiments and enthusiastic teachers. They also said that they answered their questions straightaway and the relevance of topics was made clear.

SECTION 2: Validation of results

A standard technique for validating social research findings is triangulation, (Neuman, 2003; Merriam, 1998). There were fifteen participants in this research. Of these fifteen participants, twelve rated their ability to succeed in the science units of their current TAFE course at less than five out of ten. The aim of the research was to identify some of the factors involved in the development of this lack of confidence. The research identified twelve teacher-related themes and four student-related themes, each of which was common to a number of participants. Research literature detailed later in this section supports these themes.

One of the measures used to confirm the validity of the data was looking at data which shows the opposite effects. As previously described, each participant was asked to rate their confidence level to successfully pass their current TAFE science courses on a scale of one to ten. When these confidence levels are compared with their school experiences in science, there is a definite correspondence. Those participants with low confidence levels at TAFE, all described poor school science experiences while those participants with high confidence levels described satisfying and enjoyable experiences in their school science. The three participants, who felt confident about their TAFE science, described their school science lessons as fun and interesting with good teachers, clear explanations, and help available when they needed it. The researcher, who has had a life-long interest and enjoyment of science, can add her own experiences of science lessons at school which

agree with those described by the confident participants. As discussed in previous sections, in contrast, the non-confident participants described their school science lessons as boring with large amounts of copying notes and poor explanations with teachers who did not encourage questions. Several of the non-confident participants found their science teachers intimidating and dreaded their science classes while at school. A majority of these non-confident participants expressed difficulty in getting help when they needed it. This contrast of experiences between the confident and non-confident participants supplies an internal validation of the extracted themes.

Further internal validation comes from statements made by participants in relation to other subjects in which they did well (or badly), at school and also in reference to their current TAFE science studies. Almost all participants reported an increase in their scientific confidence after experiencing the different approach used in their current TAFE courses.

Note that Daphne described a similar poor experience in her mathematics classes to that described by many of the participants in reference to their science classes which Daphne perceived as the reason for her to have low confidence in her ability to do mathematics. Daphne was one of the participants with a high confidence level in science.

There are a number of reports in the literature which support the descriptions given by non confident participants of their school science classes. The research reported above by Appleton (1995) on page 93, in which he compared pre-service teachers' attitudes towards science before and after a science unit shows similar results to the current study. Appleton's pre-service teachers describe their school science in similar ways to that of the non-confident participants in the current study. The researcher's current science education students have also made similar comments about their school science.

Abrahams' study of British school children produces a similar picture, (Abrahams, 2009). This strongly suggests that many secondary school science classes are conducted in the manner described by the participants. They consist largely of copying board or textbook notes or listening to lectures. Practical classes are less boring but are also very rigid consisting of following exercises from a textbook.

Primary school science and early secondary school science are more interesting for students. Reports from the ROSE project (2004), TIMMS (2003, 2007) and PISA (2006, 2009), previously discussed, all show that from being very interested in science at age eleven, most children lose interest in science by age fifteen. It is very important to identify why that early interest is lost. If secondary school science lessons are largely spent in writing notes and reading textbooks, this would account for the loss of interest in science by children. Combined with a teaching approach that discourages questions, secondary science would be both boring and difficult to follow.

The research literature tends to confirm the validity of individual themes identified in the current research. As discussed on pages 89 and 90, several of the teacher-related themes which were extracted from the data are concerned with poor teacher-student relationships (as perceived by the participants). Lederman (1992) showed that a positive relationship between student and instructor was an important determinant of student success in a subject.

The research data strongly linked school science teacher pedagogy and attitude to developing low confidence levels in science. The way to reduce or change this in the future is by effecting changes in teacher attitude and pedagogy. Hence published literature was examined to identify possible causes

of this teacher behaviour. A factor that may be relevant here is that 45% of responding schools in the government sector have difficulty retaining science teachers (Harris, Jensz and Baldwin, 2005). This leads to difficulties in staffing of schools with qualified science teachers. Symington, (1980) investigated the effect of scientific knowledge on primary teachers' science teaching and found that it made a difference in the amount of teacher direction given in class. Symington confirmed this finding by discussion with a range of primary teachers who stated that when they lacked confidence, they became more directive in their teaching. They suggested that when they had increased science knowledge they felt more confident and taught differently.

While there is no evidence from the research concerning qualifications or subject knowledge of the participants' science teachers, the descriptions given by some of the participants in the current study suggest that they experienced an authoritarian style from their science teachers. Keavney and Sinclair, (1978) suggested that teacher anxiety tends to lead to a more authoritarian approach to their teaching. Koehler and Grouws, (1992) also confirmed that teachers' behaviour is influenced by their content knowledge, their knowledge/understanding of pedagogy and their knowledge of teaching methods specific to their subject. Large unruly classes as described by some participants would also tend to lead to a more authoritarian style of teaching and would make it more difficult for teachers to give individual help. Many of the participants stated that their teachers were not willing to answer questions after classes. This may have been due to heavy workloads carried by their science teachers.

One of the dominant themes identified was that most of the participants described their science classes as boring. They described their classes as mainly taking notes from board or textbooks and lectures or their teacher reading from a textbook. This describes a rigid mode of delivery that does not offer any opportunity for an inquiry approach to science topics. As reported earlier Smith, (1990) found that inadequate qualification of teachers in either content knowledge or the pedagogy of their subject can lead to a situation where teachers are relying heavily on notes and textbooks. The mode of delivery can also be influenced by the choice and sequence of content material. Fennema and Franke, (1992) note that teachers' knowledge and beliefs are related to student achievement. Where the beliefs are important is the ways in which they influence selection of content material and which areas will be concentrated on. Another relevant aspect is a teacher's own beliefs about learning and knowledge. Reporting a survey of pre-service teachers, Foss and Kleinsassel, (1996), observed that pre-service teachers may have a belief that the learners must have some inborn talent to succeed at mathematics and this could mean that it is not their responsibility to use a variety of pedagogical approaches and so they may opt for teaching students how to solve problems rather than developing concepts. One participant, (Therese) stated that her science teacher was only interested in and willing to help the students who in Therese's words were 'up and forward' (Therese, Interview, 2007).

Looking at science teaching from the perspective of the teacher provides an indirect validation of the participants' stories. Several of the participants in the current study recognized and commented on the difficulties that their science teachers were working under, citing large classes and poor discipline. Goodrum et al, (2001) conducted a survey of 505 teachers and 4023 students from Years 5–11. The report from this survey showed that students saw school science as difficult and irrelevant and teachers felt tired, disillusioned burnt-out and undervalued by the system.

As discussed in several sections, a large scale survey of science teachers in Australia was conducted by Harris, Jensz and Baldwin, (2005) for The Centre for the Study of Higher Education at Melbourne University. Data from this study on Australian science teachers shows the sorts of pressures that they are currently experiencing. It also demonstrates a high level of dissatisfaction with 53% of government school science teachers dissatisfied and feeling undervalued This would lead to a situation where secondary school science in many schools in the government sector is not taught at an optimal level. This result is an indirect validation of the participants' descriptions of their school science classes and teachers.

Sean-Smith, Banilow, McMahon and Weiss, (2001) carried out a report of The National Science Survey of Science and Mathematics Education Trends from 1977 to 2000. They showed that many science teachers did not feel prepared to teach their subject. This is an American survey but is relevant to Australia as similar trends are shown here. The Melbourne University study cited above also noted that most science teachers felt that the curriculum contained too much theory and extensive theory content in a curriculum leads to extensive note-taking and bookwork.

The Impact of the Researcher

A possible area of bias concerns the impact of the researcher on the participant and vice versa. Goffman, (1959) suggests that people adopt particular personas for particular aspects of their lives and that people being interviewed will sometimes 'play' to the audience (the researcher in this case). It is difficult to assess this effect, but every attempt was made to have the participants relaxed and comfortable in the interviewing environment and to feel that they could talk freely to the interviewer.

It was emphasised that the researcher was interested in gathering the science stories of the participants. It was also stressed what precautions would be taken to ensure confidentiality and that at no stage would participants be identified by name in any published or circulated material. All participants were told that they could withdraw at any stage and their interview transcripts would be returned to them

Rosenthal, (1976) described what he called the "experimenter effect". This involves an unwitting partnership between researcher and participant where the researcher has somehow transmitted the idea of the expected results which the participant then supplies. Participants may tailor their responses to supply what the researcher wants. This effect was minimised by ensuring inclusion and consideration of all responses before drawing conclusions from the data. The explanations referred to above, during which the researcher emphasised that she did not know what the results would be and that she was interested in collecting the 'science stories' of the participants, should also minimise this effect. The use of open-ended questions in interviews is recommended by Brenner, Brown and Canter, (1985), and also by Rubin and Rubin, (1995). This technique avoids leading or directing the participants. Open-ended questions and probes were used in the current study. A relevant aspect here as stated is that the data from the interviews was not what the researcher anticipated it would be. In addition, the participants' voices were used in reporting the results. That is direct quotes from the interview transcripts were used to illustrate the themes extracted from the data (See Chapter 4). Using actual transcripts in the participants' own words, avoids what Merryfield, (1990) describes as constructing a scenario which may not reflect the true situation. Connelly and Clandinin, (1990, p.2), describe narrative inquiry as 'the ways humans experience the world.' What

was collected in the current study was stories of Beauty Therapy students' experiences in and of science and the reporting of the study endeavoured to convey these stories accurately by using the participants' own words.

SECTION 3: Reflections

The study highlights the importance of good teaching practices in secondary school – not just for development of confidence but also for developing interest in a subject. For science which has consistently shown a drop in enrolments over the last two decades, it is relevant that participants in the study described dreading their science classes and being intimidated by their science teachers together with a boring presentation.

Principles of Learning and Teaching

It is clear from the interview data that, for many of the participants in the current study, the six Principles of Learning and Teaching (PoLT, 2001), were met poorly if at all in their science classes. This particularly applies to principles one, three, four and six, that is:

- The learning environment is supportive and productive
- Students' needs, backgrounds, perspectives and interests are reflected in the learning program
- Students are challenged and supported to develop deep levels of thinking and application
- Learning connects strongly with communities and practice beyond the classroom

Harry was the only participant who stated that he extended his science learning outside the classroom. He said that if he was interested in something he would look it up and read about it. He also used to enjoy watching science programmes on television. There is no evidence from the other transcripts that there was any extension of the participants' science learning outside the classroom while they were at school. This is in contrast for example to Zara's mathematics teacher who she described as smiling and taking the class outside to measure things. It is also very clear that for many participants, their learning needs were not met in their school science classes. Therese for instance stated that her teachers were only interested in the students who were doing well and let the others fall behind. This is a situation which can arise with large classes when a teacher may concentrate on those students who were most likely to succeed. The transcripts also show no evidence that the participants were challenged and supported to develop deep levels of thinking in their science classes and in fact were actively deterred by having large volumes of material to copy from textbooks or board notes. As described earlier, the learning environment for many participants was neither supportive nor productive when they dreaded going to science classes. In addition, the inability to get help experienced by most participants suggests that their needs were not reflected in their science learning program.

Teacher/student relationships

There are a number of complex issues underlying the experiences of the participants. One of these is the relationship with their teachers. It is clear from the interviews how important it is that a student feels comfortable with their teacher and able to ask questions without fear of being humiliated or embarrassed in front of their peers. It is also clear that some participants perceived their teachers as intimidating and felt that their teachers neither valued nor respected them. The participants described doing well in subjects where they had some rapport with their teacher. Most of the participants described enjoying science and doing well until they had a particular teacher so clearly their relationship with their teacher was extremely important.

Leung, (1995) noted that factors which may prejudice teachers against learners include: low socio-economic status, poor discipline, physical appearance and also that some aspects of special needs children may be unacceptable to particular teachers. There may have been some underlying factor(s) involved in Annabelle's strong perception that her teacher disliked her. Koehler and Grouws, (1992), suggest that student characteristics will affect teacher behaviour. They suggested that learning outcomes are based on a learner's actions or behaviours which in turn are based on how they see themselves as learners and on what the teacher does or says in the classroom, together with the learner's attitude towards the subject. They further stated that teachers' behaviour is influenced by their content knowledge, their knowledge/understanding of pedagogy and their knowledge of teaching methods specific to their subject This again is relevant to the current study with almost all participants stating that the way their science was taught at school was mostly by taking notes from the board or from textbooks – an approach the participants found boring and difficult.

Speering and Rennie, (1996), observed that teacher-student relationships were an important determinant of a student's attitude towards a subject. This was shown in the current study by Yvonne, who elected to take Legal Studies instead of continuing with science (even though she enjoyed science), because she 'hated' the science teacher. (She had been taught by this particular teacher for other subjects).

Pedagogy

Tobin and Fraser, (1990) carried out a study of what comprised a 'good' science teacher and concluded that the best science teachers had the following qualities in their lessons:

- Allowed interesting hands–on activities which were well integrated with the theory
- Employed a range of strategies to make their lessons fun and interesting
- Were skilled at explaining concepts clearly and simply
- Communicated their enjoyment of teaching science

This description is in direct contrast to descriptions of science classes by those participants who had poor science experiences at school. It relates directly to comments made by participants who enjoyed their school science and also to statements made by participants in relation to other subjects which they had enjoyed at school.

Shulman, (1987) suggested that beyond their content knowledge, teachers also needed to know how to teach their particular subject. Harry referred to this saying that his teacher could have used stories to make it more interesting and many of the participants would have liked clear visuals and explanations to aid their understandings. They commented that where these were supplied in their current TAFE science courses, they experienced few problems with their understanding. Several participants commented on the seriousness of their science teachers describing them as never smiling or cracking jokes. Many participants also described their school science teachers as lacking in enthusiasm for their subject which made it difficult for their students to develop or maintain interest in the subject.

Practical work

Most of the participants enjoyed their practical work but cited several issues in relation to it. These included poor linkage with the theory; the relevance not explained; poor explanations; old and dirty laboratory facilities and limited opportunity for exploring topics or following an inquiry process.

The older participants described their practical work in terms of learning how things worked and being very interesting. Over the last two decades, limitations on practical work in schools have been imposed by a variety of factors. Many schools have poor resources and antiquated equipment, together with a lack of technical support or preparation time allotted to teachers. It is sometimes impossible for a teacher who may have consecutive classes to clear up after one class and prepare the necessary equipment for the next class. While most secondary schools do employ laboratory technicians to perform this function, they are usually only part-time and not able to spend time laying out equipment or clearing up after classes. Current safety requirements in school laboratories are very strict and this has limited the scope of some of the practical work in science particularly with large classes. Several participants stated that their science classes were large with thirty or more students. Large classes with poor discipline restrict what can be done due to safety and supervision issues as well as a fear of litigation should something go wrong. Hackling, (2009) conducted a survey of laboratory technicians in Australian secondary schools and stated that the aims of the new National Curriculum are unlikely to be met without adequate resources and staffing in school laboratories.

Other science teaching issues

Several participants commented on large classes and poor resources in terms of laboratory equipment. Goodrum et al, (2001) compiled a report on science teaching from a survey of 505 teachers and 4023 students from Years 5–11. Goodrum et al noted that there was considerable variation between schools in the quality of science teaching and resources available. These differences range from schools with no science programs in place to those which are well resourced with an enthusiastic and well qualified science teaching staff. These differences, in part, reflect the priorities of different schools. Those schools with large numbers of students from non-English speaking backgrounds inevitably place a high importance on literacy skills. However, while this situation is unlikely to change appreciably without a considerable increase in funding, other factors are more dominant as is evidenced by the declines shown in other countries which do have a higher education funding rate than Australia. Goodrum et al also reported that curriculum pressures result in time pressures on teachers and facilities.

The relevance of preferred learning styles

Preferred learning styles were an issue that the researcher had expected to dominate the research findings. For this reason, all participants were asked whether their school science was presented in the way in which they preferred to learn. While almost all participants agreed that the presentation was not ideal, this did not emerge as a dominant factor in their stories. It obviously had some impact as almost all the participants including those who had positive science experiences at school, commented on the teaching methods used in their current TAFE courses and in those subjects in which they had done well at school. Many of these comments referred to use of visuals and diagrams together with clear connections to the relevance of the material. These comments clearly relate to preferred learning style. Moreover many of the participants complained that their school science was all writing from notes on the board or reading from textbooks. Again these statements suggest that material was not presented in a way that was compatible with the participants' preferred learning style. It is recognised that increased maturity may account for some of the improvement in attitude towards science seen at TAFE. But, participants all backed up their statements about the TAFE science with examples of what was done that was better and made it easier. Foremost among these was the ability to ask questions and get help when they needed it. The other major aspect mentioned by the participants was clear explanations with visuals and diagrams together with the topic being covered in several different ways. In addition, at TAFE, the participants stated that the relevance of what they were doing in science was made clear to them. Bertha made an interesting statement that before attending her current Technical and Further Education (TAFE) course; she rated her level of ability to succeed in her current TAFE science courses as one out of ten. After starting her current TAFE course, she revised that to eight out of ten. (Bertha, Interview, 2006).

Science Anxiety

One of the basic assumptions underlying this research is that a high number of Beauty Therapy students lack confidence in their ability to do science although this is not warranted by their actual performance in science tests. Most participants had passed their school science successfully and stated that they were doing well in tests and assignments they had had in their current courses. Despite this many of them gave themselves a very low confidence rating for their ability to succeed in their science courses. In addition, some of them expressed anxiety about studying science (Bertha, Constance Xandra and Zara). The low confidence levels combined with anxiety about succeeding in their current TAFE science courses corresponds with the term 'science anxiety' which was coined by Mallow, (1978). As a result of further studies, Mallow (1994), concluded that females did not have an innate science anxiety. Although this does not mean that they cannot acquire it from the prevalent culture. This is a relevant fact as most of the Beauty Therapy students are females. The two male participants in the study, in contrast to the females, did not express anxiety about passing their current science courses, although both rated their ability in science at four out of ten. This rating does not suggest a high level of confidence. There may be other factors impinging on the anxiety – for example, one of the males said that if he failed he could do something else. That comment suggests that maybe males have a larger range of options open to them or possibly that they are more aware of their options.

Statements made by the participants concerning their progress in subjects other than science and their final school level suggest that all participants fall within the average or higher range of abilities. This correlates with observations made by the researcher (described earlier), when she was teaching science to Beauty Therapy students.

Summary

In summary, the analysis of the interviews of this group of TAFE students shows a very clear connection between the science teaching they experienced in early secondary years and the development of confidence in their ability to do science. It also highlights the importance to the student of feeling respected and valued by their teachers and comfortable in the knowledge that help is available when needed. The validity of these experiences can be confirmed from literature sources which also demonstrate possible reasons behind the sorts of experiences described by the participants in this study,

An explanation of the development of low confidence levels in science is shown by the stories that emerged from this data. Those participants who exhibited low confidence levels in science all described enjoying science (and school), until they had a particular science teacher who demonstrated some or all of the following points:

- Did not encourage questions
- Did not show respect or caring for the students
- Made intimidatory or derogatory remarks
- Gave few or poor explanations
- Had a boring presentation - did not tell the 'story'
- Expected students to do their learning from textbooks or board notes
- Was not enthusiastic
- Did not smile or crack jokes
- Made poor connections between theory and practical work
- Few or poor explanations of practical work relevance not made clear
- Practical work involved following a set of directions rather than a true experimental or inquiry-based process

This did not occur at the same level for all participants and so seems unlikely to be due to increasing difficulty or complexity of the subject or to be age or maturity related.

The reaction to this by the participants was:

- Initial disengagement
- Self-blame for lack of understanding
- Becoming 'lost'
- Blocking

- Playing truant from school
- Rebellion – in one case leading to expulsion from the school

A number of other areas were probed during the interviews; these included the influence of gender; peer pressure and cultural issues. However the participants were adamant that these areas had not affected their science studies in any way.

The results of the study clearly showed that the teacher is most influential in the development of students' attitudes towards science and to their confidence in their ability to succeed in science studies. This particularly applies to the early and middle secondary years of schooling.

It is evident from contrasting the statements made by the participants who were confident about their science ability and also from statements made by the participants about other subjects in which they had done well at school that a number of qualities can be displayed by teachers which initiate student confidence in science and which lead to continued interest in science studies. These qualities include the following points:

- The teacher is enthusiastic and interested in the subject matter
- The teacher employs a range of strategies to engage and interest their students. These include the use of diagrams, visuals and colors together with clear explanations
- The teacher's explanations are in terms that the students can follow; that is the teacher is aware of their non-technical language when they give explanations
- The teacher is approachable and willing to assist students who need help and be aware of when a student is falling behind
- Both the current and future relevance of what they are studying made clear to the student
- The teacher ensures that there is a clear connection between theory and practical work and that students understand the relevance and importance of the practical work they are doing

The SIS guidelines (Goodrum et al, 2001), correlate well with the above points

The MYPRAD Initiative (2001) identified six principles of teaching (PoLT) that teachers should follow for optimal learning outcomes. Both the SIS guidelines and PoLT should be followed in addition to the points listed above to achieve optimal outcomes in science learning. This particularly applies to PoLT principles one, three, four and six, that is:

- The learning environment is supportive and productive
- Students' needs, backgrounds, perspectives and interests are reflected in the learning program
- Students are challenged and supported to develop deep levels of thinking and application
- Learning connects strongly with communities and practice beyond the classroom

An interesting aspect identified in the current study is that the three mature–aged participants all reported a strong interest in science with positive experiences in school science together with a high level of confidence in their ability to succeed in their current TAFE courses. This correlates with the science experience of the researcher who had an excellent grounding in science and who thoroughly enjoyed her school science. So what changed and when? The researcher's memories of school

science include extensive practical work with (what seemed to us as students) to be genuine investigative studies. There were certainly also textbooks and notes and writing up of experiments but these were somehow interesting and relevant. We also studied science from a historical perspective which presented information as a developing story. It gave us an insight into the work of early scientists and how impressive their achievements were. Above all, the researcher's teachers were not only knowledgeable; they were enthusiastic and very accessible and willing to answer questions.

To achieve a change, it is necessary to examine why science teaching in some schools is not reflecting the guidelines suggested above. It is likely that it is related to the conditions that science teachers are working under. There have been large numbers of government reports in most western countries over the past three decades prompted by concerns over falling enrolments and standards in science. For example, research by Brennan, (1994) and also by Dekkers and De Laeter, (2001) showed that there has been a progressive decline in the number of students completing science subjects in Australian high schools since 1970. This is in spite of guidelines being in place for the optimal teaching of science and goals for student outcomes since 1979. The decline in science enrolments has also been experienced in both the USA and the UK.

What is required to obtain the ideal?

What is necessary is to look at ways of maximizing the existing resources and of reducing workloads on science teachers and generally improving their working conditions. Some professional education for science teachers in either or both content and pedagogical knowledge would be helpful.

Sinclair and Owsten, (2006), surveyed a group of Canadian mathematics and science teachers from grades six and seven, about their attitudes, knowledge and classroom practice both before and following a professional development program which used a blended approach of lectures and on-line work over a two year period. The course involved two one-year programs designed to enhance subject knowledge and pedagogical skills. The results showed an increase in content knowledge and increase in motivation with changes in classroom practice. There was also increased collaboration between teachers. These factors applied even to teachers who were previously confident about their content knowledge and pedagogical skills. This shows that it is possible to make big improvements from a relatively small investment.

Brandt, (2003) has developed a list of ten requirements for a school to function as an optimal learning environment. One of these requirements is that there should be an incentive structure for adaptive behaviour. This means that good teaching practices are appropriately rewarded. This is not the current practice in Victoria (or Australia generally) and hence there is no extrinsic or intrinsic incentive for teachers to spend time in professional development. Moreover there are far more attractive remunerations available in industry and research for science graduates in Australia. Brandt also noted the need for incentives to perform at an organisational level. What incentives are there for a school to embark on a costly science program at present? Brandt also stated that school organizations need to be aware of their aims and that these should be related to curriculum and student learning goals so that all participants are aware of these aims. Of his other requirements, he noted the importance of recognising that a school is an open system sensitive to the external environment which includes social and community concerns and political and economic factors.

Certainly Victorian primary schools generally are well oriented with respect to community but not so well in regard to political and economic constraints where their power is limited.

The studies reported above (Sinclair and Owsten, 2006; Brandt, 2003*)* all suggest that the current situation of many secondary science teachers can be remedied and improved with the appropriate professional development. However there need to be incentives for teachers to do it with rewards in terms of increased pay/recognition. This was suggested by the OECD (Reported in The Australian 2011). Intrinsic rewards would follow through improved personal pedagogies which would not only make their teaching easier, but they would see the results in improved learning outcomes for their students. Time needs to be provided and support mechanisms put in place for teachers who undertake professional development. There needs to be more time and support mechanisms, such as laboratory technicians to allow for preparation and cleaning up within the classroom situation. Also, as noted above governments are unlikely to appreciably increase funding in the near future so whatever is adopted needs to be both low cost and effective.

The study carried out by the Harris, Jensz and Baldwin, (2005), referred to earlier shows that science teachers generally are operating under considerable difficulties in Australia. In itself this factor will influence the teaching of science. This situation will continue while there is a shortage of science graduates in Australia and those there are can obtain better pay and conditions in areas other than teaching. The fact that Independent and Catholic schools are not experiencing as severe a shortage as schools in the government sector (Melbourne University study cited above) indicates that this is a relevant factor. Fifty-three percent of Australian science teachers surveyed in this study indicated that they would not be staying in teaching. This indicates an extremely high level of dissatisfaction.

Heavy workloads, large classes and curriculum pressures were all given as reasons for this dissatisfaction. Also important was the low status accorded to science teachers and low priority given to teaching and resources for science in many schools. The other factor of relevance is that there is a large variation between schools in both available resources and time committed to science. Goodrum et al, (2001), noted this and also a Victorian Government inquiry into the promotion of mathematics and science education (Tabled 2006), commented on this. In part this may be due to some schools having a large number of students who come from a background where English is a second language and hence directing resources into literacy programs

It is not a situation unique to Australia. Osborne and Collins, (2000), completed an extensive survey of 16 year olds (that is, at the end of compulsory schooling) in the United Kingdom, together with their parents and teachers. They found that although science was considered to be very important, many students and their parents were dissatisfied with their learning experiences in science and the teachers felt that much of this dissatisfaction was valid. This is exactly the situation reported by participants in the current study. Osborne and Collins concluded that it stemmed from the rigidity of the curriculum framework which was a complaint voiced by many of the Australian teachers in the Melbourne University report cited above.

An American study on the influence of resources and support on teachers' efficacy beliefs was carried out by Tschannen-Moran and Woolfolk Hoy, (2005). In this study, 225 teachers, with experience ranging from 1 to 29 years, were asked to rate their efficacy beliefs with their sense of support (from colleagues, community and staff) and abundance of teaching materials and satisfaction with personal efficacy. Experienced teachers reported higher levels of support and satisfaction than inexperienced teachers. Only resource materials correlated with teachers' sense of

efficacy. The efficacy was rated on a nine point scale for each of three questions from nothing to a great deal. It also indicates that professional development where teachers are supported and able to interact with others in a similar discipline created a large improvement in motivation as well as content knowledge.

Recommendations

1. There needs to be further research in the area of this study to identify the types of teaching practice used in Victorian school science lessons to gain an understanding of the quality of the pedagogies used in the teaching of science. Similar statements to those made by participants in the current study have been made by pre-service teachers in the researcher's science education classes. Many of the pre-service teachers display a similar lack of confidence in their ability to succeed in science studies as the Beauty Therapy students, suggesting that there is a high percentage of schools where the science teaching pedagogies can be improved. What are the differences between schools with a good science culture and other schools? Is there a difference in the pedagogies employed in private schools compared to government schools? Are safety regulations too stringent and limiting what can be done in practical classes?

2. This study also has implications for teacher training and teacher qualifications. Research is needed into the type of training that will enable teachers to identify and use appropriate pedagogies for science instruction. There has already been a great deal of research in this area (Tytler, 2007, 2009 and Tytler, Waldrop and Griffiths, 2004) but it does not seem to have resulted in improved long-term practices in schools.

3. There needs to be further research into the ways in which students would like to learn science and also what their expectations are. The Osborne and Collins, (2001) study referred to above indicates that the interest in science is there among both children and their parents, but the reality of their school science was disappointing and this finding was backed by their teachers. This also correlates with this research where most of the participants were disappointed with their school science and found it boring and difficult. There are some pointers from the research: participants wanted more visuals, they wanted to hear the 'stories' of science. They wanted enthusiasm and interest from their teachers and they wanted links to their daily lives. They also wanted to know that their class contribution was valuable.

4. It would be useful to assess the possibilities for changing the emphasis of the curricula to stress the importance and relevance of science studies. At present many schools place a low priority on science studies in favour of literacy. A change in curricula emphasis could lead to a more balanced education system. If teachers are educated to use science as a means to teach literacy, they would find rich areas for engagement and student interest.

5. In addition, ways to reduce the workload of science teachers and assessing which types of professional development would be most useful to them need to be investigated. The recently released OECD report on Australia's school system recommended that career structures for teachers be tied to teaching standards. (The Australian, August 18, 2011). However, in practice this may be difficult to assess and monitor as teaching students in some

disadvantaged and low socio-economic areas often has more important priorities than achieving academic excellence. Moreover what represents success and a high achievement for one student may not be for another.

6. The science teachers from schools within small areas could be grouped together to establish a network between the teachers in an area. Rather than each teacher working out unit plans for the entire science curriculum in their school this could be shared among the teachers in the network. This has several major advantages: firstly it reduces the workload for individual teachers; secondly it enables teachers to specialize in particular areas of the curriculum thus sharing expertise; thirdly it enables a communication and discussion forum between teachers with similar interests which prevents them from feeling isolated particularly if they are teaching in schools where there is a heavy emphasis on literacy programs at the expense of science programs and resources; fourthly it may enable some sharing of resources between schools in an area; it would also ensure that schools within this area all cover the same unit structure; finally these local networks could facilitate professional development in order to meet the learning needs of participants. The specializing of teachers for particular areas gives maximum use of the most valuable resource – that is the teachers' knowledge base.
7. These network groups could be established by science educators who could act as facilitators and mentors in the initial stages and also deliver professional development where required. The networks would have the advantage of minimal cost to establish and would maximize existing resources especially the knowledge resources of the teachers involved. The networks once established could also communicate via wikis or similar internet forums.

The New Zealand Ministry for Education has for many years operated regional teacher communication networks in secondary schools (SouthTeach). These provide a forum for collaboration between teachers of particular disciplines and schools. Both students and teachers can access the information on websites and in addition, they hold informal meetings and professional development courses. All schools are online and the project is aiming for a blend of online and face-to-face teaching and providing a common space where teachers can pool resources and there is collaboration between students, teachers and communities. They are aiming eventually to have all teachers enrolled in the project with a Diploma of E-learning which will operate through the University of Canterbury.

What the researcher visualizes is different to this concept in that the networks would operate between smaller groups of teachers within a region with the purpose of sharing both workloads and knowledge resources of the teachers involved. This would have the advantage of all the teachers within a network getting to know the other teachers at a personal level. This would provide a valuable adjunct to the MYPRAD project (Tytler, 2001).

The researcher recognises that there is already a state wide network of science teachers with the Science Teachers Association of Victoria (STAV). However it is not easy or practical for some teachers to get to STAV meetings as they may be distant from their home base and involve a larger group of people. In addition, most would have little input into the programs offered.

The researcher has considerable experience of science education for pre-service teachers and has also spent many years teaching science and believes that this system would work very well. The idea

is based on the efficacy of a teaching stratagem used in the science education unit for the pre-service teachers. This strategy involves small groups of students developing and teaching a unit of science to their peers. The groups are able to pool their science knowledge which in many cases is very limited and do the necessary research. Similarly to the Beauty Therapy students in the current study, many of the pre-service teachers start the course with a low confidence level in their abilities to succeed in science studies and also a dislike of or disinterest in science. After completing the course, interest motivation and confidence all increase very markedly. This is a similar result to that described by Appleton (1995, p. 94). It also agrees with the Sinclair and Owsten, (2006), study where there was an increase in both content knowledge and pedagogy skills following an ongoing professional development course. Sinclair and Owsten also reported that the teachers involved in their study remained in contact at the conclusion of the study. The researcher believes that it could also work well for groups of teachers in other areas such as mathematics.

There are many other areas which can lead to an improvement in science teaching such as increasing and modernising resources and facilities. However this would require a considerable increase in government funding which appears unlikely in the current economic climate.

Conclusion

In conclusion, the research has identified a clear relationship between the teaching practices of the science teachers of these participating Beauty Therapy students in a TAFE organization which undermined their confidence in their ability to succeed in science studies. The research has identified areas which were particularly influential in this process. In particular, the participants stated that they could not get help from their science teachers when they needed it or were afraid to ask for help because of fear of being ridiculed in front of their peers. This inability to obtain help was a dominant factor in their loss of confidence as science is a subject in which the knowledge builds successively and if the earlier work is not understood, the later work is also not understood. Some participants were discouraged by the use of derogatory or sarcastic remarks from their teacher leading them to feel that they were not valued by their teacher and that nobody cared what happened to them. Others felt intimidated by their science teachers and in a few cases were actively frightened of their science teachers. Another dominant point reflected in previous research was that for most participants, their science lessons were boring and consisted largely of copying notes from the board or from textbooks. Participants commented on their improved understanding of science with their current TAFE courses where there were a lot of visuals and diagrams with clear explanations. Other points raised concerned the lack of variety in their science lessons. Of particular interest to the researcher was the fact that the participants expressed interest in the stories underlying science and scientists. Participants would have liked more enthusiasm from their teachers and to hear more of the ‘stories’ of science. They indicated that the relevance of their science studies was seldom clear to them and overall that it did not meet their earlier expectations of the subject.

This research’s contribution to knowledge has confirmed that the participating students who encountered a combination of rigid pedagogy and poor teacher attitudes in their school science developed a lack of confidence in their ability to proceed with their science studies. This situation was exacerbated by difficulties these students experienced in getting help from their teachers and in some cases by perceived intimidatory behaviour by their science teachers. In extreme cases, they

developed anxiety towards and a dread of science studies. The researcher believes that this lack of confidence is a crucial determinant of students opting not to continue with science. The research also adds further evidence to published studies (discussed in Chapter 2) showing that students find rigid pedagogies employed in teaching science to be boring. By showing the importance of teacher attitudes as perceived by these students to the development of confidence in the ability to succeed in science studies, this research adds to published studies, (also discussed in Chapter 2) showing that teacher attitudes affected student success.

It is recommended that further research be undertaken into the pedagogies employed in science teaching in Australia and also into how adolescents would like to be taught science. The recommendations of this research are that small area collaborative networks be established between groups of schools enabling group planning of curricula and sharing of knowledge and possibly resources. In addition, professional development needs could be facilitated by these networks.

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APPENDIX I

Information to Participants

Marian Hinwood is a postgraduate student completing a Doctor of Education degree in the School of Education, Faculty of Arts, Education and Human Development at Victoria University. she would like to invite you to be a part of a research study that will focus on an investigation into Beauty Therapy students' attitudes and perceptions of science. Marian is interested in exploring your experiences in science and how they relate to your current attitudes and perceptions of science. The key aim of this research is to:

> *develop individual participant portraits that provide both an explanation and understanding of the factors that have impacted on how each Beauty Therapy student has positioned him/herself in and towards science*.

Marian proposes to conduct an interview (no longer than 1 hour) with individual students who volunteer to participate. The interviews will be audio - taped and the tapes transcribed into a computer. Each participant will be provided with a transcript of the interview for him/her to validate. The transcriptions will be coded under pseudonyms to ensure confidentiality. The transcripts will then be analysed for themes and patterns. A brief questionnaire will also be administered seeking contact details, age range, school educational level; siblings/gender/position in family; cultural/family background and self-rating of science ability. The contact details are required to enable participants to confirm the accuracy and completeness of the researcher's interview summaries

The risks to you in participating in this research project are minimal. Areas of potential risk relate to fears you may have concerning confidentiality of your data or influences on your course progress. All personal details will remain confidential and will be kept in a secure place. All participants will be allocated with a pseudonym to ensure confidentiality. It is important to note that your participation or otherwise is voluntary and will not influence your progress or results in your course. You may withdraw at any stage from the research project without penalty, in which case, your transcript will be returned to you. Counselling will be available via the VU Student Services for any participant who may become distressed or anxious through their involvement in this research project.

If you have any questions or queries about this research project, please contact Marian Hinwood or A/Professor Bill Eckersley by telephone 99197453 or Email: Bill.Eckersley @ vu.edu.au

Thank you again for your interest in this research project

Yours truly,

Marian Hinwood.

APPENDIX II

Consent Form for Subjects Involved in Research

I would like to invite you to be a part of a research study that will focus on an investigation into Beauty Therapy students' attitudes and perceptions of science. I am interested in exploring your experiences in science and how they relate to your current attitudes and perceptions of science. I propose to conduct an interview (no longer than 1 hour) with individual students who volunteer to participate. I will audio-tape each interviews and transcribe the tapes into a computer. I will provide each participant with a transcript of the interview for him/her to validate. I will use pseudonyms for the transcriptions to ensure confidentiality. I will then be analysing the transcripts for themes and patterns. I will also administer a brief questionnaire will also be seeking contact details, age range, school educational level; siblings/gender/position in family; cultural/family background and a self-rating of science ability.

The risks to you in participating in this research project are minimal. Areas of potential risk relate to fears you may have concerning confidentiality of your data or influences on your course progress. I will ensure that all personal details remain confidential and are kept in a secure place. I will allocate a pseudonym to each participant to ensure confidentiality. It is important to note that your participation or otherwise will not influence your progress in your course and that you may withdraw at any stage without penalty, in which case, your transcript will be returned to you.

Any queries about your participation in this project may be directed to the researcher (Name: Marian Hinwood or her supervisor Dr Bill Eckersley ph: 99197453 Email: bill.eckersley@vu.edu.au)). If you have any queries or complaints about the way you have been treated, you may contact the Secretary, University Human Research Ethics Committee, Victoria University of Technology, PO Box 14428 MCMC, Melbourne, 8001 (telephone no: 0399194710).

CERTIFICATION BY SUBJECT

I**,**

Of

I certify that I am at least 18 years old* and that I am voluntarily giving my consent to participate in the study entitled:

"A study of influences and experiences contributing to the attitudes a group of vocational students have towards science."

being conducted at Victoria University by: Marian Hinwood and Dr Bill Eckersley

I understand that this will involve an interview of one-hour duration conducted by Marian Hinwood and completion of a brief questionnaire on my background details

I certify that the objectives of the study, together with any risks and safeguards associated with the procedures listed hereunder to be carried out in the research, have been fully explained to me by Marian Hinwood and that I freely consent to participation involving the use on me of these procedures.

I certify that I have had the opportunity to have any questions answered and that I understand that I can withdraw from this study at any time and that this withdrawal will not jeopardise me in any way.

I have been informed that the information I provide will be kept confidential.

Signed: **.....}**

Witness other than the researcher: **}** Date: .....

[*PLEASE NOTE: WHERE THE SUBJECT/S IS AGED UNDER 18, SEPARATE PARENTAL CONSENT IS REQUIRED; WHERE THE SUBJECT IS UNABLE TO ANSWER FOR THEMSELVES DUE TO MENTAL ILLNESS OR DISABILITY, PARENTAL OR GUARDIAN CONSENT MAY BE REQUIRED.]

APPENDIX III

Questionnaire to record personal details

- Please fill out the following details on the form provided:
- Name
- Address
- Contact number/Email address
- Age
- Education – level
- How many sisters and brothers do you have?
- What is your position in the family?
- What is the cultural background of your family?
- What language(s) are spoken in your home

APPENDIX IV

Probes Used in Interviews

- How would you rate your ability to do science?
- Tell me how you feel about science/scientists.
- Describe your school experience in science to me
- What is your earliest memory of science?
- How do you see yourself in relation to science?
- How did you feel when you found you had to study science? Why?
- Which area of science do you find most interesting?
- Describe your general school experience
- Are there any influences related to your gender that have influenced your subject choice?
- Tell me about any influences on your attitude to science
- How did you make your subject/career choices?
- What social factors have been relevant to your learning experience?
- In your opinion, was your education compatible with your preferred way of learning?
- How do you see science as being relevant to your Beauty Therapy course?
- Please explain?
- What were your initial reactions on discovering that the Beauty Therapy course contains a number of science subjects?
- What other experiences have you had that have exposed science learning?