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**SUPPORTS AND BARRIERS TO ACHIEVEMENT
IN SECONDARY SCHOOL CHEMISTRY:
EXPLORING THE TEACHING AND LEARNING
OF YEAR 12 CHEMISTRY IN SAMOA**

A thesis presented in partial fulfilment of the requirements for the
degree of Doctor of Philosophy in Education

at Massey University, Manawatu
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Abstract

Within the Samoan context, education is seen as critical to furthering the national goal of have sufficient qualified citizens who can create opportunities within an increasingly more technical and market-orientated economy. Science education is seen as playing an important role in this, yet despite significant government investment students' achievement in science has continued to be a concern.

This research focused on exploring the supports for and barriers to students' achievements in Year 12 chemistry in Samoa. The study involved students and teachers from one chemistry classroom from each of three government co-educational secondary schools: two from urban areas and one from a rural area in Upolu, the main island of Samoa.

Using participants' interviews, classroom observations, and samples of students' work, case study methodology was used to investigate participants' perspectives of supports and barriers to learning and teaching senior chemistry in Samoa. Analysis of both common and distinctive ideas across the three case studies revealed the ways in which factors that relate to Samoan cultural values, the institution, and the classroom could act as barriers or supports to students' chemistry achievement. This happened in complex ways. While some factors were considered by both teachers and students to be either a barrier or a support to chemistry learning, others were perceived differently by teachers and students, and depended on context. Implications for practice include: the use of *fa'a-Samoa* to support learning, the need for professional development around teachers' beliefs and classroom practice, the need to take into account students' perceptions of meaningful learning in chemistry, and the role of Samoan language in the learning and assessment in chemistry in Samoa.

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Chapter 1 Introduction

1.1 Introduction

Education is one of the three greatest areas of concern in Samoa and other Pacific nations (UNDP, 2004). Other areas of concern include health and unemployment. In the Samoan education sector, there is a stated need to make education more relevant to national needs. As such, “learning programmes [should be] based on students’ own experiences; the encouragement of independent and creative thought; confidence in expression and desire for knowledge; and preparation of the individual, [in order that s/he can make] progress towards higher learning” (Ministry of Education Sports and Culture, 2000, p. 3). The development of such learning programmes is important to promote students’ achievement across all subjects. Success in education contributes to sustaining the momentum of the Government of Samoa (GoS) reforms, which support the national vision: that is “for every Samoan to achieve a better quality of life” (Economic Planning and Policy Division, 2000, p. 1).

At the present time, access to education is viewed as a basic human right, in addition to it being an essential element, for both human and social development (UNDP, 2004). Not only should education be universally accessible, it must be of high quality, relevant and sustainable, in order to equip citizens to improve their society and gain benefit from social and economic progress. Thus, the GoS has given a high priority to educational development and it has invested extensively in science education. However, students’ achievement in science subjects and mathematics has continued to be a concern for a number of years (Ministry of Education Sports and Culture, 2006c). This study aims at exploring the teaching and learning processes that occur in Year 12 chemistry classrooms in Samoa to identify factors that influence students’ achievements.

There are important reasons for being concerned with students’ achievement in science and chemistry. Many scholars and science researchers in western countries suggest that lower levels of science achievements may be associated with a decline in students’ academic motivation for science studies (Telford, 2010). Simultaneously the Organisation for Economic Cooperation and Development’s (OECD) educational policy recognises that in addition to achievement, an important educational outcome for today’s young people is an

attitude that gives participation in science an important place both in their current life and their future (OECD, 2007). This educational goal is often expressed in terms of commitment to lifelong learning. The implication is that it involves more than just the choice of scientific careers or further education, but may also be expressed through participation in science activities and projects within students' communities. Hence, interest in science involves how students view scientific information and activities and it is assumed that these reactions underpin their choices to participate in science activities in both their present and future lives.

Promoting student achievement in science brings substantial benefits both to the individual and to society. For the individual, improved school achievement increases career earnings, promotes environment awareness, improves health and well-being and actually lengthens life (OECD, 2007). Increased numbers of qualified students (with professional and scientific knowledge) are also able to cope with the labour requirements and work within a more technical and market-oriented economy (Ministry of Education Sports and Culture, 2007).

This chapter provides an overview of education in Samoa, including its historical background, the structure of the education system at the secondary school level and the development of science education in Samoa. This overview will provide the reader with a broad understanding of the context within which the study was conducted. This is followed by the rationale and aims for the current study and an overview of the organisation of the thesis.

1.2 Overview of education in Samoa

1.2.1 Historical background

Samoa's traditional education system was largely concerned with passing on collective knowledge and values and the cultural traditions of Samoan society. This is to ensure the survival and continuity of Samoan values and cultural traditions (Meleisea, 1987a; Thaman, 2000); which were "measured in terms of performance and appropriate behaviour in the multiple contexts in which they have to live" (Pene, Taufe'ulungaki, & Benson, 2002, p. 3). Young people were taught to understand the structure of society, the various roles

attributed to their elders, and their own place within the structure of their extended family, village and the wider society. In these situations, learning occurred through listening, memorising, observing and doing. Through these processes, young people acquired the knowledge and expertise from the teacher, who was always an elder or a chief. Students were given access to knowledge, which was deemed appropriate to their age, gender and status. While learning in the traditional system adopted transmissive designs and patterns, quality and relevance in education has always existed in Samoa (Thaman, 2000). In this regard, learning was more about their day-to-day living which was seen as worthwhile learning amongst extended family members (*aiga*); between families and villages (*nu'u*) and between one community and another (Townsend & Bates, 2007).

Between 1830-1900 Samoa was greatly influenced by the historical activities of western missionaries (Coxon, 2007) and later by colonial activities (Tofaeono, 2002) of western countries. During this time the Samoan way of thinking transformed. For instance, they thought that they would become civilised people if they converted to Christianity. Thus the adoption of Christianity meant that Samoans also adopted the Christian ways of doing things as well as how to educate others (Coxon, 2007; Meleisea, 1987b) in a formal, western education system. This new system of education meant that learning was organised and institutionalised and therefore it greatly impacted on the traditional system—not only in regards to its aims and content, but also in regards to the methods of teaching, learning and the way learning was assessed (Coxon, 2007; Meleisea, 1987a). Essentially the focus of this new system of education in Samoa involved the uncomplicated act of telling students what to learn. In a sense “the architecture and routines of the school, and the content and processes of the curriculum, were primarily designed to prepare the young to be compliant and productive workers” (Teasdale, Tokai, & Puamau, 2004, p. 4). Schools were seen as the normal delivery mechanism for education with values and as a result they conditioned subsequent developments in terms of schooling as well as development of young people. Formal schooling became strongly accepted and it had a great influence on many Samoans. For example, Samoa’s preparation for independence brought about a strong desire for a well-educated population, who had a well-developed understanding about international relationships and governance. This modernisation offered island people enlightenment and civilisation and it initiated a strong desire for economic development (Sanerivi, 2000).

Education is valued in Samoa as a means to acquire international understanding and it is a way forward, both for economic and social development (Fuata'i, no date). For instance, the first Government of the Independent State of Samoa in 1962 revealed the need to “strengthen secondary level education particularly [in] ... science to meet the manpower requirements of government, agriculture, industry, commerce, teaching and other pursuits” (Treasury Department, 1969, p. 15). Under these conditions, the expectations associated with the modern school system are to (i) promote economic progress; (ii) transmit culture; and (iii) to cultivate children’s intellectual and moral development (Thaman, 2001). These three expectations became the foundation of educational reform and the same expectations are also being emphasised in current education policies as being fundamental to education development in Samoa.

The overriding goal of Ministry of Education, Sports and Culture (MESOC) is the development of education, sports and culture that satisfy basic human needs. This means that cultural and spiritual values and associated attitudes need to be nurtured. It also involves the development of knowledge, skills, and sporting potential to prepare capable citizens, who will then contribute to national development, such as Samoa’s economy, and a healthy nation. Since science and technology education has often been perceived as the driving force behind economic development in many countries (for example, Droni, 2000; Gilbert, 2003; Little & Green, 2009; OECD, 2007), Samoa (with the support of other development partners such as New Zealand, Australia and Japan) is investing heavily in science and technology education in the hope of promoting economic development in Samoa. Therefore, science educators recognise the need for science education to adopt new ideas and principles in order to ensure the successful achievement of the Government’s investment.

Samoa, like other Pacific countries, has worked closely with development partners, such as New Zealand, Australia and Japan, to improve the quality, efficiency and effectiveness of Samoa’s education (Teasdale, 2005). The main rationale was that every Samoan person would have full and equal access to a quality basic education and to be able to reach their potential. This rationale is essential for all young people’s growth and development and without such foundation, society could not develop effectively. Not only should education be universally accessible, it must be of high quality, relevant and sustainable, in order to

equip citizens to improve their society and thus ensure benefits from social and economic progress. The key to this progress is to have sufficient, qualified students (with professional and scientific knowledge), who can work within an increasingly more technical and market-orientated economy (Ministry of Education Sports and Culture, 2007) that Samoa is facing today.

1.2.2 Current views of education

Views of education in Samoa suggest that students learning are measured using examination results and their progress through education is dependent on their results. Such views are supported by Thaman's (2001) description of the characteristics of formal education in the Pacific school. She states that examination results in junior secondary level are used predominantly for entry into senior level and that the results "are being used as the main indicator of what students know" (p. 7). However, Aikenhead (2011) claimed that such science teaching is aimed at students memorisation of facts and procedures to obtain the correct answers needed for success in tests and examination. Thus, the students are not encouraged to work on understanding chemistry but they are simply working to be credited for taking chemistry (Aikenhead, 2011; Costa, 1997). Gao and Watkinson (2002), in their study of teachers' conceptions of teaching physics in China, suggest a need to adjust the focus from transmitting knowledge for examination to changing children's perceptions of the world. Children want to learn and do science rather than just passing exams. Studies in New Zealand and China, however, showed that such change cannot happen unless teachers realise the need for it and challenge traditional views about school science learning (Gao & Watkins, 2002).

In Samoa, educators and parents desire that the educational system be excellent, and generally Samoans agree that excellence in education involves students displaying the highest level of achievement as measured by exam results (Ministry of Education Sports and Culture, 2007). Low levels of student achievement in science subjects limits the number of science graduates in tertiary education in Samoa and there is a shortage of science teachers (Leiatua, 2001). The study of Boujaoude and Attieh (2008) in high school chemistry sheds some possible light on problems in learning science which include "the abstract and highly conceptual nature of science ... and teaching methods do not seem to make the learning process sufficiently easy for students" (p. 233). The former is considered

very serious as chemistry is widely perceived as a difficult subject because of specialised language and abstract conceptual nature (Gabel, 1999) . The latter identifies that the prevailing teaching practices do not actively involve students in the learning process and seem to prevent them from taking charge of their learning (Boujaoude & Attieh, 2008; Francisco, Nicoll, & Trautmann, 1998). In fact, the way science is taught today does not prepare the students for doing science in the real world (or to participate in tertiary studies) but rather on transmitting facts for passing exams.

While achievement (whether academic or exam result/grade) is of great importance in all levels in education, Samoa's secondary school science education in particular continues to experience low level of students' achievements. There is a lack of literature available about the factors influencing student achievement in the Pacific and Samoan contexts. Most of the literature highlighted in this study is from western studies and western researchers. This study aims at exploring the teaching and learning processes that occur in Year 12 chemistry classroom in Samoa to identify supports for and barriers to students' achievements with a particular focus on factors relating to the classroom: instructional methods, physical environment, and social environment

1.2.3 Overview of science education

International literature states that the emphasis of science education should be on inquiry learning, where students are encouraged to gain meaningful understanding of scientific concepts (Abd-El-Khalick, 2012; Chin & Osborne, 2008). Learning in this sense is through active participation in class activities (Sesen & Tarhan, 2010) and with the support of constructive and contextualised instructional strategies (Suaalii & Bhattacharya, 2007) and positive learning environments (Fraser & Chionh, 2009). Basically, the most successful progress is made when teachers are able to identify the knowledge and skills held by students and then provide experiences that challenge students to modify their knowledge and skills in order to construct deeper scientific understanding. As stated in the Samoa science curriculum 2006-2015, "science learning is enhanced when teachers:

- engage students in active learning;
- place learning in relevant contexts;

- use the students' background knowledge and understandings as the starting point for new learning;
- deconstruct the knowledge that makes up a science concept and select learning activities that build up the students' knowledge and understanding in steps;
- use a variety of teaching strategies; and
- provide a variety of learning activities”.

(Ministry of Education Sports and Culture, 2004, p. 19)

Science education in Samoa aims to “support the growth and development of all students and assists them to:

- develop a more scientific understanding of the world around them
- develop investigation and problem solving skills
- make decisions relating to appropriate use of the science and environment
- understand the links between all areas of science”

(Ministry of Education Sports and Culture, 2004, p. 4)

These goals are consistent with international trends in school science education. For instance, Bull, Gilbert, Barwick, Hipkins and Baker (2011) identify four purposes for science education in the compulsory school sector. “These are:

- preparing students for a career in science (pre-professional training),
- equipping students with practical knowledge of how things work (utilitarian purpose),
- building students' science literacy to enable informed participation in science-related debates and issues (democratic/citizenship purpose), and,
- developing students' skills in scientific thinking and their knowledge of science as part of their intellectual enculturation (cultural/intellectual purpose)”.

(Appendix A p. 15)

The secondary education system in Samoa becomes very competitive and therefore students must do well in order to continue to higher level education. Students are expected to become more specialised in their subject areas during Years 12 and 13 in preparation for tertiary level. In science, for example, the students need to do well and pass biology, chemistry and physics in Years 12 where they sit Samoa School Certificate (SSC) in order

to gain entry to Year 13 where they sit Pacific Senior School Certificate (PSSC). PSSC determines whether a student gains entry into science courses in tertiary education. Unfortunately, there is a low level of achievement in these subjects in primary and secondary schools (Ministry of Education Sports and Culture, 2007). Consequently, there is a possibility that the sustainability of chemistry and other advanced science education in Samoa secondary schools is doubtful.

1.3 Rationale for the study

Factors that influence students' achievements in science subjects and suggestions for improvement have been well documented in international literature (for example Chiu & Khoo, 2005; Darling-Hammond, 2000; O. Lee & Luykx, 2007; McDermott, 1990). Despite this, science achievement in Samoa remains low and indeed continues to fall (Ministry of Education Sports and Culture, 2000, 2006c). Perhaps the Samoa educationists and policy makers could not relate to what was happening in education to the findings from the international literature. In fact, there has been no research done in this area in Samoa and in particular, the factors influencing students' low achievement levels in science as well as mathematics (Ministry of Education Sports and Culture, 2006c). Although the Ministry of Education, Sports and Culture continues to implement school improvement programs with the aim to support students' learning from Years 1 to 13 there is little evidence about the effectiveness of such programmes in terms of achievement levels.

The new school improvement programmes were developed to support goals and principles of Samoan education. These goals encourage: (i) development of comprehensive and enriching curricula; (ii) development of active, interactive and creative pedagogies; (iii) development of impartial evaluation and assessment methods; and (iv) support for individuals and society, through a humane education system (Department of Education, 1995; Ministry of Education Sports and Culture, 2005). The four goals are, in turn, addressed through four key principles: (i) *equity*, which requires the fair treatment of all individuals, in the provision of educational opportunities; (ii) *relevancy*, which is defined through a system which is meaningful, recognisable, applicable and useful; (iii) *efficiency*, which is demonstrated through management practices that ensure optimum use of resources, efficient services delivery, effective communication and co-ordinated decision-

making; and (iv) *quality* (Ministry of Education Sports and Culture, 2006c; Ministry of Finance, 2008).

In order to achieve the goals and principles of Samoan education, the New Zealand Agency for International Developments (NZAID) and the GoS has spent millions of dollars (Ministry of Education Sports and Culture, 2007) to modernise the secondary education curriculum and to produce learning materials and teacher training for all subjects. In addition, MESC launched an Institutional Strengthening Program (ISP), which aimed at strengthening its services and raising students' achievement in all learning areas, through a focus on teaching/learning processes and the conditions which supported it (Fepulea'i, 2004; Tuioti, 2005). However, there is a need to explore the teaching and learning processes within the classroom, prior to any decision making and in particular in regards to the provision of appropriate resources.

1.3.1 Aim of the study

The aim of this study is to explore the teaching and learning processes evident in senior secondary school chemistry classes. Specifically, it explores factors that influence students' achievements in three Year 12 chemistry classes from three different schools in Samoa. These factors include both the supports and barriers to achievement that occurred during the teaching of one of the units in the organic chemistry strand¹. The outcome of this study is to develop implications and recommendations for practice in order to assist in the improvement of teaching and learning, within Year 12 chemistry, in Samoa.

1.4 Thesis organisation

The thesis is organised into eight chapters. This first chapter provides a background of the Samoan education system focusing on secondary education together with an overview of science education. The second chapter reviews the relevant literature on the teaching and learning of chemistry and the supports for and barriers to students' achievements in chemistry. The third chapter describes the research methodology used in this study. It identifies the research questions and describes methods used to seek answers to the

¹ The Year 12 chemistry content is comprised of six strands: the structure of atoms; quantitative chemistry; organic chemistry; oxidation and reduction; inorganic chemistry; and principles of physical chemistry.

research questions. It also describes the research participants; the research design; data collection methods; the research procedures; ethical considerations; and data analysis.

The fourth, fifth and sixth chapters present the key findings from the three individual case studies, which focus on the support and barriers to students' achievements in chemistry.

Brief discussions on the key findings are provided together with support from the data.

The seventh chapter discusses the themes across the three case studies, both common and distinctive ideas and their meanings in terms of the aim of the study and the literature. The eighth chapter provides the conclusions to this study followed by the contribution to knowledge and the implication of this research for practice. Suggestions for future research are proposed.

Chapter 2 Literature Review

2.1 Introduction

This chapter outlines a review of international literature with a focus on science and chemistry education. The review contains views mostly from the international literature. Some come from the literature available from Samoa or the Pacific region around the focus of the current study. The first section begins with a brief overview of the behaviourist, knowledge acquisition and constructivist learning perspectives to describe the learning processes embedded within science classrooms. Constructivists' perspectives are further explored in details with reference to individual and social constructivist views. This is followed by a review of the literature related to the supports for and barriers to students' achievements in science with a particular focus on the classroom: instructional methods, physical environment and social environment. Finally, a short summary of the chapter is provided.

2.2 Learning perspectives

A “perspective is not a recipe; it does not tell you just what to do. Rather, it acts as a guide about what to pay attention to, what difficulties to expect and how to approach problems” (Wenger, 1998, p. 9). Learning however, as Wenger continues, is not something that is tied to a particular time, place or group of people nor is it necessarily dependent on instruction. Nevertheless, schools are responsible to society for bringing about learning. How we understand learning has implications for outcomes we value and how we seek to achieve (Driver, Asoko, Leach, Scott, & Mortimer, 1994). Views of learning have the potential to serve as a framework to describe the teaching and learning processes and for creating further possibilities when we want to do something about learning as individuals, as communities and as organisations. For the purpose of this thesis, three broad views of learning are distinguished: behaviourism, knowledge acquisition and constructivism (with a focus on individual and social constructivism).

2.2.1 Behaviourism

Murphy (2012) described behaviourism as “based on the principle that scientific learning is a behavioural change that can be induced via appropriate stimuli; it follows the work of Ivan Pavlov (1849–1936), Thorndike (1874–1949) and Skinner (1904–1990)” (p. 177).

From this perspective teaching and learning needs to focus on observable behaviours and acquisition of new behaviours (Pritchard, 2005). The teachers study behaviours of students and help them adapt using positive reinforcement and discipline strategies that will encourage them to display behaviours they are seeking from students (Boghossian, 2006). Desirable behaviours are reinforced and undesirable behaviours are ignored or punished. Both positive and negative reinforcements increase the possibility that the behaviour will happen again. In contrast, punishment decreases the likelihood that the behavior will be repeated. Learning according to behaviourists “occurs gradually rather than suddenly or significantly” (Watson, 1997, p. xii) and they described it as a change in behaviour in the learner (Boghossian, 2006; Skinner, 1985). Teachers therefore reinforce desired academic responses with praise or rewards. Undesirable behaviours on the other hand, results in teachers taking something (such as privilege) away from the students temporarily until they can show positive behaviours or administering a punishment (such as detention) (Skinner, 1985).

Pritchard (2005) described behavioural learning perspectives as a model of how people learn from their experience with much of their behavioural responses being conditioned by events from their background and early experience. People learn from their daily experience, encounters of new situations, responding in the ways they think best to suit the occasion and accumulating knowledge of the likely consequences to their behaviour (Duit & Treagust, 1998). In addition to learning through personal consequences people can also learn through observing (and imitating) the behaviour of others and the consequence that has for them (Bandura, 1969).

Behaviourists’ approaches however have been criticised for suggesting that most human behaviours are mechanical and that human behaviours are simply the product of stimulus-response associations. In particular, the approach ignores human being’s complex thought processes (cognition) and emotions (A. Bandura, 1989). In social learning theory, for example, Bandura argued that cognitive factors cannot be ignored if learning is to be

understood (A Bandura, 1989). Bandura pointed out that knowing that certain behaviour will be rewarded or punished (e.g., from observing the experience of others) shapes the behaviour just as much as the rewards or punishment themselves. Behaviourism dominated the western formal educational landscape in the early 20th century (Boghossian, 2006; Duit & Treagust, 1998; Forman, 2012; Jenkins, 2000). Around that time, Samoa had already been introduced to a formal western education system, resulting mainly from historical activities of western missionaries from 1830-1900 (Coxon, 2007) and by colonial activities from 1899-1961 (Tofaeono, 2002). Education in Samoa became heavily influenced by both behavioural viewpoints and the notion that knowledge was something that could be transmitted to learners. These two sets of ideas were compatible with traditional education in Samoa and were therefore easily adopted in the context of more formal education. Prior to the formal education system, all education of the young people occurred in the family or in the villages. When formal education was introduced, part of that education was removed from the family (Silipa, 2008) and the village, and the elders in the family and the village were no longer the sole source of knowledge (Fletcher, Parkhill, Fa'afoi, Taleni, & O'Regan, 2009; Mead, 1943).

Since the early days of missionaries and colonialists in Samoa, the formal western education system introduced to Samoa have undergone major changes to accommodate the contemporary needs of the people of Samoa and the MESC. However, old ways of learning (such as behavioural perspectives) continue to have some influence on teaching and learning within Samoa's classrooms and particular influence in conjunction with views about teaching as knowledge acquisition.

2.2.2 Knowledge acquisition

The perspectives of learning through “knowledge acquisition makes us think about the human mind as a container to be filled with certain materials” (Sfard, 1998, p. 5) or information dispensed by others (such teachers) or from textbooks (St. George & Bourke, 2008). So the conception of teaching could be viewed as using teacher-centered teaching strategies because “knowledge acquisition is ... through a one-way transmission process from the teacher to students” (Cheng, Chan, Tang, & Cheng, 2009, p. 320).

In Pacific cultures the view of learning as knowledge acquisition is also present. The knowledge which is passed on from one generation to another allows people to “connect to their ancestors who have come before them and their children who will come after them” (Fua, 2005, p. 111). In Samoa, learning was “through listening, memorising observing and doing” (Coxon, 2007, p. 266). This is to ensure the young acquire the knowledge from the experts and adults for survival and continuity of Samoan values and cultural traditions. Basically, learners try to acquire the knowledge and store information in memory (Richard E. Mayer, 2002; Sfard, 1998) to “be measured by achievement tests” (St. George & Bourke, 2008, p. 124). The teacher’s role is to transmit “what counted as valuable knowledge (from a liberal or classical curriculum) ... [and] rote learning was the fundamental ingredient to good teaching” (G. Lee & Lee, 2007, p. 142). For instance, Dickie and McDonald (2011) found that Samoan children use a lot of rote learning and oral presentation of biblical texts that were read and committed to memory. Mayer (2002) claimed that the tactic of memorising information is often preferred by the learners because it is seen as being more efficient if an education system is heavily exam-based like that in Samoa (Ministry of Education Sports and Culture, 2005, 2007). In this regard, teachers tend to put a lot of emphasis on curriculum implementation and presentation of information necessary for students to pass exams.

While knowledge acquisition seems to be a common aspect of teaching in western education and is implemented in the Pacific islands educations, it is described in the literature as being closely tied to human cognition, particularly in terms of memory and what learners can do to make themselves better receivers (Richard E. Mayer, 2002; Sfard, 1998). The learner is seen as a passive receiver of information and the teacher is viewed as the sage on the stage who presents the information or knowledge that is required in the curriculum or from the texts (A. King, 1993; Schwerdt & Wuppermann, 2011). However, if science is a dynamic socially constructed set of ideas and new knowledge of the natural world, then transmission of knowledge and memorisation are unlikely to yield understanding of how knowledge develops or of the nature of science itself (Driver, et al., 1994; J. Osborne, 2010; M. Ratcliffe & Millar, 2009; Songer & Linn, 1991; Treagust & Duit, 2008).

2.2.3 Constructivism

In the “last two decades of the 20th century, one of the most influential views of learning is the perspectives known as constructivism” (Applefield, Huber, & Moallem, 2000, p. 36). It was also recognised as an explicit referent for science teaching (Matthews, 2002; Taber, 2006, 2011). Major texts on teaching and learning science were branded as taking a constructivist view (J. J. Mintzes, Wandersee, & Novak, 1998). In addition to the influence of constructivism on texts, constructivist classroom instruction was advocated to promote cognitive processes in science (R. E. Mayer, 2009). For example, teaching strategies were suggested such as “group learning, where two or three students discuss approaches to a given problem with little or no interference from the teachers” (Mansour, 2009, p. 30). This was seen as giving the students opportunities to construct knowledge, having first been provided with learning goals by the teacher.

Constructivism “is an epistemological view of knowledge acquisition emphasizing knowledge construction rather than knowledge transmission and the recording of information conveyed by others” (Applefield, et al., 2000, p. 37). It involves constructing, creating, inventing, and developing one’s own knowledge and meaning of realities based upon interpretations of one’s experience (Jonassen, 1991; Liu & Chen, 2010; Taber, 2011). Under the above conditions, learning is seen as an active process of sense making, which occurs in the minds of learners as they attempt to construct a meaningful representation of the information (Phillips, 1995). How one constructs knowledge is a function of the existing knowledge, experiences and understanding, mental structures and beliefs that one uses to interpret objects and events (Bodner, Klobuchar, & Geelan, 2001; Jonassen, 1991).

Kirschner, Sweller and Clark (2006) argue that constructivist views of learning that emphasise minimal guidance during classroom instruction are ineffective. They cite research which they argue supports the idea that “novice learners should be provided with direct instructional guidance on the concepts and procedures required by a particular discipline” (Kirschner, et al., 2006, p. 75). However, Taber (2011) argues that effective constructivist teaching is “not to provide direct instruction or minimal instruction but optimum levels of instruction” to monitor and support the students’ learning (p. 57). In this regard the teacher continuously shifts from presentation and expositions towards giving opportunities for students to engage in a range of activities either individual or in

groups (Taber, 2011). The notion of the teacher assisting student learning through the ‘zone of proximal development’ suggests that teacher guides learning from a perspective that understands how learning is dependent upon individuals’ existing conceptual structures and prior knowledge (Taber, 2011). Moreover, teacher–student or student–student discourses inside the classroom may be considered as a form of scaffolding (Rojas-Drummond & Mercer, 2003). Essentially, “scaffolding makes the learning more tractable for students by changing complex and difficult tasks in ways that make these tasks accessible, manageable and within students’ zone of proximal development” (Hmelo-Silver, Duncan, & Chinn, 2007, p. 100). In any classroom, there are individual “differences ... and therefore effective learning is only likely to be possible when there is constant matching of current learning to learning needs” and their existing conceptual structures (Taber, 2011, p. 54).

Constructivist views of learning became the major theoretical influence in the reforms of the current western formal education in Samoa. Reform in education included the development of a single stream curriculum with supporting teaching and learning materials (Coxon, Enari, Iosua, & Sepuloni, 2006). A Samoan government document which outlines approaches to science learning suggests that “learning is a process by which new understandings are constructed. Students learn best when they take action themselves to generate and create meaning” (Ministry of Education Sports and Culture, 2004, p. 18). In fact views of constructivism supports the very nature of science is that it constructs knowledge from observations, experimentation and reasoning. Thus, teachers are seen as playing a key role in this process and much of the learning that occurs is viewed as a direct result of the teachers’ quality instruction aimed at: accommodating different learning styles, encouraging discussion, and promoting inquiry and problem solving (Ministry of Education Sports and Culture, 2006b).

Inquiry in science involves the “process of posing questions about the world in which we live and then investigating and evaluating possible answers to the questions” (So & Ching, 2011, p. 559). However, evidence from the western literature shows that there is very little inquiry occurring in today’s school science classrooms and many students lack inquiry skills such as asking questions, investigating and drawing conclusions (Palmer, 2009). Duschl

(2008) suggested that the new perspective of science education should focus on what pupils need to do in order to learn science.

Individual constructivism

Central to individual constructivism is the idea that learning is a “function of how the individual [learner] creates meaning from his or her experiences (Jonassen, 1991, p. 10). In this regard, children’s learning is a process of personal, individual, and intellectual construction arising from their activity in the world (Taber, 2012; Treagust & Duit, 2008). Knowledge of a specific phenomenon is represented as a conceptual presentation that conveys different interpretations of a phenomenon. These are related to individuals’ conceptual abilities and internal reorganisation of ideas (Driscoll, 2005; K. Tobin, 1993; K. Tobin & Llana, 2010; Watkins, 2000). Such reorganisation of ideas was described by Piaget as an “interplay of assimilation and accommodation that progressively leads to knowledge of reality” (Riegler, 2012, p. 241). In addition, Piaget’s views of constructivism incorporate the importance of understanding what each individual needs in order to acquire new knowledge and learn at his or her own pace. Teachers’ observation of students and the assessment of prior knowledge and skills are paramount to this process. Essentially, asking questions of students’ prior knowledge is part of “meaningful learning and scientific inquiry” (Chin & Osborne, 2008, p. 39).

Considering the above views, it would be interesting to know how the process of individual construction of knowledge occurs in Samoa, especially most of the activities at home, village and church are carried out in social contexts (Silipa, 2008).

Social constructivism

An important branch of constructivist views of learning emphasises that learning is shaped by social interaction with peers or with adults (Driver, et al., 1994; Duit & Treagust, 1998; Rogoff, 2003; Watkins, 2000). The types and quality of social interactions between experts (adults or teachers) and learners can significantly impact learners’ appropriation of knowledge (Cobb & Bowers, 1999). Basically, knowledge and understandings are constructed when individuals engage socially (with peers or with adults) in talk and activity about shared problems or tasks. Making meaning is thus a dialogic process involving persons-in-conversation (T. Crawford, 2005). Learning is seen as the process by which

individuals are introduced to a new idea by more skilled members using familiar strategies or tools (Buxton, 2006).

A social constructivist view of learning emphasizes the role of the social and cultural factors in shaping learning. The literature about social and cultural factors suggests an inseparability of student mental reflection from those aspects of student activity and experience (Hawk & Hill, 2000; Leont'ev, 1981; Vygotsky, 1978, 1986). Learning in this sense is situated in tasks and everyday activities in environments that are relevant to them (J. S. Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991; Sadler, 2009). These environments or contexts are formed, in part, by the students and other participants along with available ideas, tools and physical resources. According to Sadler (2009), contexts afford and constrain what students and other participants can do and come to know. In fact, children come from different homes, communities and economic backgrounds, where they learn and acquire different funds of knowledge (González, Moll, & Amanti, 2005; Vélez-Ibáñez & Greenberg, 1992). Such funds of knowledge are “the various social and linguistic practices and the ... accumulated bodies of knowledge that are essential to students’ homes and communities” (McIntyre, Roseberry, & Gonzales, 2001, pp. 2-3). These are important factors which contribute to knowledge construction within a social context.

Views of social constructivism are familiar to the Samoans, particularly its social context and *fa'a-Samoa* where work and activities are carried out by groups, family members or members of the community (Leauepepe, 2009). Participation in activities in the community is often strongly influenced by an adult with knowledge of a particular phenomenon who gives direct instructions and guidance to help young children learn new ideas and complete tasks. Views of social constructivism are also promoted in science education curriculum, where the emphasis is on “students constructing [knowledge] from their experiences” through “the use of activities such as investigation, problem solving and group work” (Ministry of Education Sports and Culture, 2004, p. 18 & 19). In this regard, views of social constructivism tend to be more emphasised in the above document compared to individual views however, it is not yet known how or whether they are enacted in Samoa classrooms.

The discussion on learning perspectives has identified the influence of knowledge transmission and principles of behaviourism in the formal western education that was imposed on Samoa during the missionary and colonialist eras. Recent reforms in Samoa education shifted the emphasis of its educational policies towards constructivist views of learning and teaching. Elements of the three learning perspectives however, can be seen in Samoan society. While exploring the teaching and learning of Year 12 chemistry in Samoa, the researcher may get an idea of how these are played out in the classroom and in particular how some of these may provide supports for or barriers to students' achievements.

2.3 Factors that influence students' achievements in science

As educators/teachers we all strive to help our students achieve, however, studies conducted in different countries show a number of factors that influence science achievements. For example, Areepattamannil, Freeman and Klinger (2011), Boujaoude and Attieh (2008), and Bowen (2000) identified factors related to classroom instruction. Factors relating to students' motivational beliefs were identified by Bryan, Glynn and Kittleson (2011), while Sesen & Tarhan (2010) and Fraser (2007) found those relating to learning environments. Fletcher, Parkhill, Fa'afoi, Taleni, & O'Regan (2009) highlighted factors relating to the culture of Pacific island students who are living in New Zealand. These factors, both identified as support (Fletcher, et al., 2009; Waite, 2010) or barriers (Fletcher, et al., 2009; Haynes, Tikly, & Caballero, 2006; Lloyd, 2008; MacKeracher, Stuart, & Potter, 2006; Seo, 2003; Wallace, 2012) are not mutually exclusive and may overlap or act together to compound the problems faced by individual students and teachers in science and other subjects.

This study aims to examine the teaching and learning processes found in Year 12 chemistry classrooms in Samoa in order to explore supports for and barriers to students' achievements. In order to look at supports and barriers, the following sections will look at the literature about teacher beliefs and knowledge, teaching quality, classroom instructional methods, the classroom physical environment and the classroom social environment with a particular focus on science classrooms.

2.3.1 Teacher beliefs and knowledge

Teaching quality refers to what teachers do to promote student learning inside the classroom. This section examines teachers' beliefs about good teaching, content knowledge, and pedagogical content knowledge, as these may affect teaching quality.

Teacher beliefs

International literature identifies that teachers' beliefs about the ways they should be teaching influences students' achievement (Fang, 1996; Hayes, 2010). Research demonstrates that teachers' beliefs about the teaching-learning process play a significant role in determining the nature of teachers' purposes in the classroom and directly affect many aspects of their professional work, including lesson planning, assessment, and evaluation (Clark, 1988; Eisenhart et al., 1988; Nespor, 1987; Pajares, 1992; Richardson, 1996). In addition, teachers' beliefs influence their decision-making during classroom teaching (Pajares, 1992).

The beliefs that teachers hold influence their thoughts and their instructional decisions (Cakiroglu, Capa-Aydin, & Woolfolk Hoy, 2012; Woolfolk Hoy, Hoy, & Davis, 2009). In turn, instructional decisions that teachers make influence the learning experiences they plan for students and hence student opportunity to learn. Science educators have recently become aware of the possible impacts of teachers' beliefs about the nature of science on their instructional plans and teaching practice (Abd-El-Khalick, 2012). Many teachers' hold traditional views of the nature of science, how students learn science, and how science should be taught (Prawat, 1992). Furthermore, Prawat suggests that positivist beliefs support traditional practice, best characterised as a 'transmission' approach to teaching and an 'absorptionist' approach to learning. Cohen (1994) argues that such beliefs lead teachers to be seen as tellers of truth who inculcate knowledge in students. Students play a relatively passive role as accumulators of material, where they listen, read, and perform prescribed exercises (Teaiwa, 2011). These views of teaching and learning constitute an important obstacle in attempts to change normal patterns of science classroom interaction.

Content knowledge and pedagogical content knowledge (PCK)

Content knowledge is described in the literature as the body of information that the teachers teach and that the students are expected to learn in a given subject (Shulman, 1986). International literature describe PCK as the knowledge about the teaching and learning of the topic or a subject matter (Kind, 2009). Some knowledge about teaching chemistry may be very different from teaching say English literature. Even within chemistry, PCK may differ depending on whether the topics are stereochemistry or thermodynamics, for example.

Grossman (1990) describes PCK as being the integration of several knowledge bases including subject matter knowledge (chemistry topic), pedagogical knowledge (how to teach the chemistry topic), and contextual knowledge (knowledge about the situation/context). Building on Grossman's work, Magnusson, Krajcik and Borko (1999) propose five interacting components of PCK:

- orientations toward science teaching,
- knowledge and beliefs about science curriculum (goals & objectives/curriculum and materials),
- knowledge and beliefs about students' understanding of specific science topics (prior knowledge and student misconceptions),
- knowledge and beliefs about assessment in science (dimensions of science learning to assess and knowledge of methods of assessment), and
- knowledge and beliefs about instructional strategies for teaching science (topic-specific activities, e.g., activities for teaching photosynthesis, as well as subject specific strategies, e.g., inquiry).

Bucat (2005) states that "there is a vast difference between knowing about a topic (content knowledge) and knowledge about the teaching and learning of that topic (pedagogical content knowledge)" (p. 2). Ensuring teachers have good content knowledge is only part of the classroom teaching and learning; possession of effective teaching skills for that subject matter is also needed. Teachers need to be able to communicate content knowledge to the students and to demonstrate how to access it, in a way that shows the place of science in the world outside school.

In Samoa, the teacher training programmes for science teachers provide a one year of foundation level science content (Ministry of Education Sports and Culture, 2006c). This is followed by a two-year diploma course which also focuses primarily on content with only one 'education' course which focuses on general pedagogy. Trainee teachers only exposure to PCK is when they watch existing teachers on practicum.

Gaining a better understanding of science teachers' PCK, its development, and the relationship between PCK and content knowledge is necessary to establish high quality science teaching (Kind, 2009).

2.3.2 Quality of teaching

The quality of teaching has been identified as potentially the largest single in-school influence on student achievement (Alton-Lee, 2003; Biggs & Tang, 2011; Hattie, 2009).

Quality of teaching is a complex issue and international literature has identified characteristics of quality teaching. These "characteristics include:

- A focus on student achievement.
- Pedagogical practices that create caring, inclusive and cohesive learning communities.
- Effective links between school and the cultural context of the school.
- Quality teaching is responsive to student learning processes.
- Learning opportunities are effective and sufficient.
- Multiple tasks and contexts support learning cycles.
- Curriculum goals are effectively aligned.
- Pedagogy scaffolds feedback on students' task engagement.
- Pedagogy promotes learning orientations, student self regulation, metacognitive strategies and thoughtful student discourse.
- Teachers and students engage constructively in goal oriented assessment".

(Alton-Lee, 2003, pp. vi-x)

In Samoa, "quality of teaching is [seen as] the product of a combination and interaction of numerous factors including the quality of intake into teacher-training institutions, teacher training programs, resources available, work environment, working conditions and

entitlements, teacher support systems, and personal qualities” (Ministry of Education Sports and Culture, 2006c, p. 44). While these factors may be necessary, they are not sufficient for quality teaching to occur. The characteristics of quality teaching identified by Alton-Lee (2003) are also necessary.

2.3.3 Classroom instructional methods

Classroom instructional methods used in “science classes vary from those that are primarily didactic or teacher-centered to those that are student-centered or learner-centered (Treagust, 2007, p. 373). A teacher-centered approach has been identified in the literature as the approach that dominated traditional education and therefore referred to as a traditional model of teaching (for example: Acar & Tarhan, 2008; Areepattamannil, et al., 2011; T. Crawford, 2005; Lord, 1999; McManus, Dunn, & Denig, 2003). The concept of teacher-centredness, whereby a teacher is providing the knowledge to the students directly is an excellent example of the both behaviourist model of learning and knowledge acquisition. Generally, a teacher-centred approach involves “more teacher talk and questions than student talk and questions, more whole class instruction, reliance on textbooks ..., recall of factual information, and a classroom in which desks are in rows facing a board” (Schuh, 2004, p. 835). The students are often seen working on the same tasks at the same time, following explicit and direct instructions given by the teacher (Daniels, Kalkman, & McCombs, 2001). Such “direct and strong instructional guidance by the teacher is more effective ... during instruction of novice to intermediate learners (Kirschner, et al., 2006, p. 84). In contrast, Taber (2011) argues that effective constructivist teaching is “not to provide direct instruction or minimal instruction but optimum levels of instruction” to monitor and support the students’ learning (p. 57).

The primary goal in teacher-centered instruction is the transfer of the required information from an expert (the teacher) to novice (the student) from a “perspective outside the learner by defining characteristics of instruction, curriculum, assessment, and management” (Schuh, 2004, p. 835). In practice, sense-making is accomplished by the teacher and transmitted to students through lecture, textbooks, and confirmatory activities in which each step is specified by the teacher for the student to record and absorb (Brophy, 2010; B. A. Crawford, 2007; Gürses, et al., 2010; Polman & Pea, 2001; Southerland, Gess-Newsome, & Johnston, 2003). Under these conditions, teacher-centered instruction is often aligned

with the transmission model of teaching which is associated with the view of learning as knowledge acquisition.

A learner-centered approach however is described as a more contemporary model which is characterised by constructive or active approaches (Areepattamannil, et al., 2011; Granger, et al., 2012; Lemke, 1990; Lord, 1999; Palmer, 2008; Peters, 2010), involving scientific inquiry (Blanchard, Southerland, & Granger, 2009; Duschl, Schweingruber, & Shouse, 2007), dialogic interactions (for example: Linn, Clark, & Slotta, 2003; McNeill & Pimentel, 2010; Scott, Mortimer, & Aguiar, 2006) and hands-on activities (Hofstein, Kipnis, & Kind, 2008; Hofstein & Lunetta, 2004; Kipnis & Hofstein, 2008; Lunetta, Hofstein, & Clough, 2007). Student-centered instructional methods shift the focus of classroom activities from the teacher to the students where they are given the opportunities to “create meaning from their own experience” (Jonassen, 1991, p. 10). In science for example, constructivist views of learning indicate that learning needs to be relevant to students’ everyday lives since this real context provides the roots from which their studies should be drawn (Watts, 1994). Mansour (2009) also added that science “needs to be related to the students’ hobbies and modern lifestyles; to current affairs and television news; to people and practices in the world ... as well as the issues in societies today” (p. 30). Vygotsky (1978) advocates that the roots of our intellectual functioning are first to be found in our surroundings and through interactions with others before they appear internally. In a classroom setting, students learn how to make sense of knowledge constructed with others which allows them to organise and relate self to circumstances. Constructivist teachers of science are more likely to provide instructions to help students build connections between their prior experience and current situations (Meyers, Nulty, Cooke, & Rigby, 2012; Taber, 2011). For example the students are provided with opportunities to engage with a range of individual and group work while the teacher monitors the development of the tasks and guide their learning. Taber (2011) argued that “constructivism as a learning theory” is where teaching involves “both student-centered and teacher directed” (p. 57) approaches.

Research on the use of student-centered instruction in science education suggests that it is a social constructivist approach (Beamer, Sickle, Harrison, & Temple, 2008; Palmer, 2008). Learning in this sense involves social interactions between experts (teachers or more expert peers) and students which have significant impacts on students’ appropriation of

knowledge (Cobb & Bowers, 1999). An indispensable element of constructivist informed science classroom teaching involve social interaction amongst peers (students), described as dialogic classroom discourse by McNeill & Pimentel (2010). In dialogic interactions, “the teacher encourages students to put forward their ideas, explore and debate points of view, and students’ responses are often tentative suggestions based on open or genuine questions, spontaneous, and expressed in whole phrases or sentences” (Chin, 2007, p. 816). Science instruction that incorporates dialogic classroom interactions leads to higher student achievement and student engagement in science (Driver, Newton, & Osborne, 2000; Duschl & Osborne, 2002). ‘Dialogic teaching’ is characterised as collective, reciprocal, supportive, cumulative and purposeful and develops meaning for students through the voicing of multiple perspectives (Alexander, 2004; Rojas-Drummond & Mercer, 2003; Scott, et al., 2006).

Hands-on classroom activities, which students are encouraged to take part in, are part of scientific inquiry that play distinctive and pivotal roles in science teaching and learning (Hofstein, et al., 2008). Mounting evidence suggests that hands-on classroom activities in science classrooms have the potential to enhance students’ higher-order learning skills such as metacognition and argumentation (e.g., Kaberman & Dori, 2009; Kipnis & Hofstein, 2008). Basically, while doing hands-on classroom activities the student are actively engaged in manipulating materials and thinking about what they are learning and doing as the teachers provide guidance for cognitive engagement (Taber, 2011). In this regard, these kinds of activities advocate the use of higher order thinking skills, such as problem-solving, analysis and creativity (Hofstein & Lunetta, 2004). Therefore, students should be both physically and mentally engaged in activities that encourage them to question and devise temporarily satisfactory answers to their questions. Moreover, students who are exposed to hands-on science instruction frequently get significantly higher scores in science than those who experience it infrequently (Klahr, Triona, & Williams, 2007).

Views about the language to teach science/chemistry

There has been an increasing interest in the central role of language in education and particularly in science education (for example: B. A. Brown & Ryoo, 2008; Chin, 2007; Martin, Sexton, Franklin, & Gerlovich, 2009; Mortimer & Scott, 2003). Such interest is a consequence, amongst other things, of studies drawing on social constructivism and the

connections between language, culture of the people involved, and cognition. Vygotsky (1978) suggests the importance of language in mediating thought. For him, language was basic to the development of thought: words are the means through which thought is formed. Furthermore Wellington and Osborne (2001) indicate that “language development and conceptual development are extricable linked ... and thought requires language and language requires thought” (p. 6). “The relation between thought and word is a living process; thought is born through words. A word lacking of thought is a dead thing and a thought un-embodied in words remains a shadow” (Vygotsky, 1986, p. 255). In this sense, speech plays a decisive role in mental processes and thus their reorganisation take place under the influence of speech.

Johnstone and Selepeng (2001) describe the problem of language in the learning of science. Their findings not only indicate that the technical language of science poses problems, but also learning through the medium of English poses problems for students whose mother tongue is not English. Researchers have gone on to look for explanations as to why the use of an unfamiliar or second-language leads to misapprehension for the learners (Aguilar, Mortimer, & Scott, 2010; Asabere-Ameyaw & Ayelsoma, 2012; Gayle, 2000; Kim & Wai, 2007). Generally, the mediocre performance of second-language learners has been explained by linguistic effects (for example: Prophet & Badede, 2009; Reder, Marec-Breton, Gombert, & Demont, 2013). Linguistic effects are a result of one’s lack of knowledge of grammar, rules of syntax as well as meanings of words used in their different contexts. First-language learners are exposed to inherent and informal methods of learning their language at an earlier stage than their second-language counterparts (Prophet & Badede, 2009). They, therefore, have an advantage of learning to apply rules of syntax early in life. This knowledge of application of rules of syntax is said to lead to the ability to ‘chunk’ English text (Klatzky, 1980). Words forming units or chunks according to the rules of syntax also form units of meaning (Howe, 1970; Pearson, Moje, & Greenleaf, 2010). Poor knowledge of these rules puts second-language learners at a disadvantage of being less able to see meaning in texts. Being frustrated by failure to see this meaning, these learners then resort to rote learning, a meaningless endeavour involving lack of linkage between new and old information. Very little is then stored permanently in memory since what is learned by rote is easily forgotten (Johnstone & Selepeng, 2001).

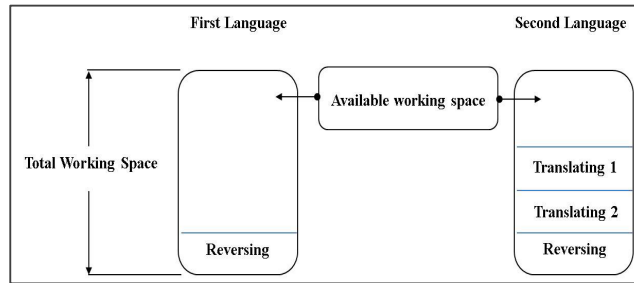


Figure 2. 1: Diagrammatical representation of the working memory space for a first and second language learner (Adapted from Johnstone & Selepeng, 2001).

According to the work of Johnstone and Selepeng (2001) (Figure 2.1), the working space holds the newly entered material and processes it. However, only familiar components (such as medium of instruction and subject-matter) are admitted into the working space based on what the student already knows and believes. If the working space has too much to hold, it has little room left for processing and, conversely, if it has too much processing to do, it can hold little information. For instance, the available working space for a first language learner (Figure 2.1.) is larger compared to that of the second language learner. Johnstone and Selepeng suggested that this means the former has more space to process and store information while the latter has little. This clearly has implications for learning. If the learner is faced with tasks requiring much processing, then little space is left for processing as well as holding information. Learning material couched in complex, unfamiliar language requires a lot of room in the working space to transform it into an understandable form. This may be due to the fact that more transformation or translation stages are required for simplifying the material to make it understandable.

Home language or the language that is spoken at home also relates to children's achievement (Smits, Huisman, & Kruijff, 2009). Children whose home language is the same as the medium of instruction have higher achievement than those who do not (Hampden-Thomson & Johnston, 2006). Educational outcomes are negatively affected if there is a difference between the languages which children speak at home and the language used in educational system. Studies both in developed and developing countries show that school children who have a home language that is different from the language of instruction at school experience higher dropout rates (C. Benson, 2005; C. J. Benson, 2000; Klaus, 2003). They also exhibit a pattern of lower levels of attainment and achievement in general (Hampden-Thomson & Johnston, 2006; Rosenthal, Baker, & Ginsburg, 1983; Rumberger

& Larson, 1998). Disadvantaged groups such as rural children, poorer groups and girls have lower school attainment and achievement when there is a difference between the home language and the language of instruction (C. Benson, 2005; Hovens, 2002; Lewis & Lockheed, 2006). Smits, Huisman and Kruijff (2009) found that mother-tongue instruction reduces non participation for the 7-16 year old group. They found that children of linguistic groups that are more concentrated in rural areas experience greater attendance problems and that the beneficial impact from mother tongue instruction on these students is greater than for urbanized children.

Impacts of examinations on classroom instructional methods

“Current assessment in Samoa education system is dominated by pen and paper tests both in schools and in national examinations” (United Nations, 2000, p. 2). Teachers therefore are more likely to teach to the test (Ministry of Education Sports and Culture, 2007). A study in China by Zhang et al, (2005) found that teaching to the exam was likely to prevent science teachers from teaching inquiry based learning. Furthermore, a study conducted in India by Jiang, Xu Garcia and Lewis (2010), which explored secondary science teachers’ orientations and practices of teaching science, showed that although the teachers tried to encourage students to be creative when developing science fair projects, when it comes to their exam there is no room for creativity: the students must follow the guidelines given by the teacher to be successful in the exam. Very often the structure of and types of questions in these exams encouraged rote learning, and so did not support an inquiry approach to learning science. This lead the teachers to be compelled to instruct in ways that mirrored the goals and design of the tests (Zhang, et al., 2005).

Time and curriculum pressures

Inviting students to engage with and talk through several activities to develop explanations for the phenomena that they observe, explore or find solutions to problems requires enough time (Scott, et al., 2006). However, evidence from the literature suggests that time for teaching and learning is often challenged by overloading curriculum (Danaia, Fitzgerald, & McKinnon, 2012; Hofstein & Mamlok-Naaman, 2011; Lujan & DiCarlo, 2006; J. Osborne & Collins, 2001). Essentially, an overloaded curriculum leaves students with little time to think and acquire deep understanding of the subject (DiCarlo, 2009; Lujan & DiCarlo, 2006; J. Osborne & Collins, 2001). Learning with understanding requires time to

allow for thinking and practice and therefore teachers must be realistic about the amount of time required for students to:

- learn complex concepts and provide the practice time to achieve the goal
- explore underlying concepts
- generate connections to other information and
- grapple with specific information relevant to the topic.

Thus learning cannot be rushed; the complex cognitive activity of information integration requires time (Bransford, Brown, Cocking, Donovan, & Pellegrino, 2000). However, the teacher is more likely to focus on covering the curriculum rather than on the students' learning.

2.3.4 Classroom physical environment

Physical environment in this study refers to the formal classroom where teaching/learning interactions occur. Anderson, Hamilton and Hattie (2004) suggest that the physical environment of the classroom, such as teaching and learning resources and facilities need to be available and accessible to all students in any classroom. In science education, science resources include equipment and chemicals for experiments and science textbooks for students and teachers, while facilities refer to the laboratory rooms. These resources and facilities must be relevant to what students are learning or are expected to learn. Minimal classroom interactions often occur when classroom resources and facilities are limited (Fraser, 2007; Talton & Simpson, 1987).

Provision of science/chemistry resources

Science resources in this study refer to chemical, equipment, and science/chemistry textbooks. Provision of these chemical and equipment in schools is important in the teaching and learning of science (Beese & Xin Liang, 2010; Ministry of Education Sports and Culture, 2005; Puamau, 2005) particularly for conducting laboratory experiments. Essentially, laboratory experiments provide opportunities to enhance students' meaningful learning, conceptual understanding and understanding of the nature of science through observation, experimentation and reasoning (Kang & Wallace, 2005; Kipnis & Hofstein, 2008). Moreover, the students are given the opportunities to gain access to various laboratory skills (such as observational, handling apparatus, measuring) (Chinn & Malhotra,

2002; Hofstein, Shore, & Kipnis, 2004; Shulman & Tamir, 1973). These skills may become useful in tertiary education where there is a high requirement for laboratory and experiment familiarity (Soti & Mutch, 2011).

The literature describes various ways in which textbooks are important in the teaching and learning of science (for example: Haggarty & Pepin, 2002; Heyneman, Farrell, & Sepulveda-Stuardo, 1981; Kahveci, 2009; Opoku-Amankwa, 2010; Pegg & Karuku, 2012). For instance Pegg and Karuku (2012) stated that “textbooks engage students in scientific reasoning, including studies of themes related to scientific literacy”. Such themes included “(i) knowledge of science (ii) the investigative nature of science (iii) science as a way of thinking, and (iv) interaction of science, technology, and society” (p. 66). In these regards, textbooks can provide support in lesson preparation and planning of class activities and how to teach science/chemistry. Students can also use these textbooks for their own studies at home or when the teacher is not available. Under the above conditions, textbooks can provide excellent and useful resource for teaching and learning of science/chemistry.

Although constructivism emphasise the roles of individual and social constructions of knowledge, the next section focus on the social interactions within the science classroom. The former emphasise that “the individual [learner] creates meaning from his or her experiences (Jonassen, 1991, p. 10) while the latter emphasises that learning is shaped by social interaction with peers or with adults (Driver, et al., 1994; Duit & Treagust, 1998; Rogoff, 2003; Watkins, 2000).

2.3.5 Classroom social environment

Ryan and Patrick (2001) revealed that “classrooms are inherently social places involving interactions between individuals, groups and the setting within which they operate” (p. 438). Social constructivists views of learning advocate that students are more likely to pursue both social and academic goals in the classroom and learning often occurs in the presence of many peers (Ryan & Patrick, 2001; Sadler, 2009).

Classroom participation

Classroom participation is the extent to which an individual engages in social interaction. It is said to occur when an individual shows interest in others' points of view (including their peers or the teachers), offers information and opinions, and is attentive to other group members during the learning activity or the lesson discussion (Goel, Johnson, Junglas, & Ives, 2010). Nuthall (2012) stated that the way students participate and engage in classroom activities sometimes appears as a function of the teacher's instructions (the activity design) and management of student behaviour. However, student behaviour and experience are a function of the students' simultaneous involvement in three different contexts. These according to Nuthall (2012) include the (i) public, (ii) semi-private, and (iii) private contexts. The visible public context of the classroom activities is designed by the teacher where one organises and manages both directly in face-to-face interaction with the students and indirectly through the design and organisation of individual and group tasks. The semi-private context of peer relationships and interactions operate within the peer culture largely invisible to the teacher, and not all of it is about school work. The private internal context of the student's own cognitive and emotional processes bring past experiences and motivations to bear on the student's perceptions and involvement in current activities. This context exists whenever and wherever the student thinks, talks or reads about the relevant content (e.g., in the classroom reading notes or listening to the teacher, in peer interactions or while doing homework).

Students' emotions and feelings

Evidence from the literature suggests that there has been a growing interest in the role of students emotions in shaping students' engagement and achievements (Linnenbrink-Garcia & Pekrun, 2011). Some researchers explore the levels of specific emotions or even a specific facial expression and how they influence students' engagement in class activities and learning achievement. A review of the literature by Boekaerts (2011) suggest that:

Emotions provide energy and impact all cognitive processes including attention, recall, event interpretations, decision making and problem solving. Once activated emotions tend to override goals and actions, even considerations of appropriateness of long-term consequences. They tend to persist in some form or other, taking on a life of their own and affecting all ongoing activities (p. 413).

There is a relationship between cognition and emotion. Aspects of cognition that are the focus of schooling—learning, attention, memory, decision making, motivation and social functioning are not only affected by emotion but intertwined within emotion processes (Fried, 2011). In addition, these emotions or feelings are also related to our motivation and state of attention to the activities that occur around us (Rubie-Davies, 2010). From a neuro-scientific perspective, Le Doux (2012) argues that the emotional brain may act as an intermediary between the thinking brain and the outside world. According to Le Doux, there is an interplay between thought and feeling and feeling and memory. When feelings are ignored, they can act unnoticed and thus have unacknowledged negative or positive influences. When flooded by our emotional brain, our working brain may have little capacity for attention to hold in mind the facts necessary for the completion of a task, the acquisition of a concept, or the making of an intelligent decision.

Emotions and feelings such as being shy and lacking of confidence are common to Samoan and other Pasifika students. Fanene's (2006) study of the New Zealand-born Samoan tertiary students found that they don't ask questions because they have a lack of confidence. In this regard, there is a possibility that the students' learning, attention, memory, decision making, motivation and social functioning may be influenced by such emotions and feelings.

2.4 Chapter summary

This chapter provided a review of relevant literature to the current study. It began with broad overview of three learning perspectives: behaviourism, knowledge acquisition and constructivism (focusing on individual and social constructivism). The discussion reveals that the ideas of the three views of learning have been part of the both the traditional Samoan education and the formal western education systems in Samoa. These views of learning seem to work alongside each other, impacting upon learning and teaching as well as education policies. For instance, during the time of missionaries and colonial activities in Samoa, education was heavily influenced by both behavioural viewpoints and the notion that knowledge was something that could be transmitted to learners as passive recipients. Recent reforms in its education system saw the introduction of constructivism views into government documents (e.g., curriculum and education policies). The emphasis is on

learning as a process of knowledge construction and students as active members to generate and create meaning (Ministry of Education Sports and Culture, 2004, p. 18).

As this study aims to explore classroom teaching and learning processes, the review of relevant literature reveals supports for and barriers to students' achievements are found in: teachers beliefs and knowledge, classroom instructional methods, classroom physical environment and classroom social environment. Classroom instructional methods can range between teacher-centered and student-centered models of teaching. Despite the two divergent views in terms of teaching and learning, evidence from the international literature shows that classroom instruction continues to use both teacher-centered as well as student centered models of teaching in science classrooms. Various teaching and learning strategies have been discussed in order to explore their potential effect on students' achievements.

The provision of science resources and laboratory facilities are factors within the physical environment which are essential in the teaching and learning of science (Chin, 2006; Hofstein, 2004; Hofstein & Lunetta, 2004). With these materials, the students gain access to and become engaged in a process of constructing knowledge by doing science (Kang & Wallace, 2005; Kipnis & Hofstein, 2008; K. Tobin & Llana, 2010).

The classroom is a social place involving interactions between individuals, groups and the setting within which they operate (Ryan & Patrick, 2001). In this sense, there is a potential value of classroom interactions in science learning. However, some of these interactions may not necessarily about the subject. Thus, the teacher's role in guiding these social interactions may be able to help students stay focused and create meaning. In fact, some researchers suggests that students should be provided with direct instruction (Kirschner, et al., 2006). However, Taber (2011) argues that it is not direct instruction or minimal instruction but optimum levels of instruction to monitor and support the students' learning.

Chapter 3 Research Methodology

3.1 Introduction

This study seeks to explore the supports for and barriers to students' achievements situated within Year 12 chemistry classrooms in Samoa. This includes consideration of teaching and learning activities occurring in the classrooms and also the perspectives of the students and the teachers involved in this study. A case study approach is chosen for this research where the “investigator explores ... multiple bounded systems (cases) over time through detailed, in-depth data collection involving multiple sources of information” (John W. Creswell, Hanson, Clark Plano, & Morales, 2007, p. 245). More specifically, as there has been no research on what goes on in senior chemistry (Years 12 and 13) classrooms in Samoa, this is exploratory case study research.

This chapter describes the methodology used in the study. It begins by stating the research question and explores the methodology underpinning, this study including a discussion on the philosophical and theoretical characteristics of case study design and why it is appropriate for this study. This leads to a discussion of ensuring quality, with reference to the overall trustworthiness of qualitative case study design. Next, ethical principles and issues concerning the participants in this particular research are considered. This is followed by a description of the three case study schools including the three cases and the research participants. A description of data collection techniques follows and the procedures for implementation of the chosen methodology. The procedure used for analysing the data is then discussed. Finally, a brief summary of the chapter is provided.

3.2 Research questions

The questions which guided the study are:

1. What factors support achievement in Year 12 chemistry classrooms in Samoa?
2. What is the nature of the barriers to achievement in Year 12 chemistry classrooms in Samoa?

3.3 Research paradigm

All researchers have different beliefs and ways of viewing and interacting within their surroundings. As a result, the way in which research studies are conducted vary. However, there are certain standards and rules that guide a researcher's actions and beliefs. Such standards or principles can be referred to as a paradigm. According to Guba and Lincoln (1998), the paradigms most commonly utilised in educational research are positivist and interpretive. The positivist paradigm arose from the philosophy identified as logical positivism and is based on rigid rules of logic and measurement, truth, absolute principles and prediction (Guba & Lincoln, 2008). The positivist philosophy argues that there is one objective reality. In contrast, the philosophical foundation of the interpretive paradigm supports the view that there are many truths and multiple realities.

The present study adopts an interpretivist paradigm. This type of paradigm focuses the holistic perspective of the person and environment (Guba & Lincoln, 2008). Additionally, the interpretive paradigm is associated more with methodological approaches that provide an opportunity for the voice, concerns and practices of research participants to be heard (Teddlie & Tashakkori, 2011). When conducting qualitative research with in an interpretivist's paradigm, researchers are more concerned about uncovering knowledge about how people feel and think in the circumstances in which they find themselves, rather than making judgements about whether those thoughts and feelings are valid (Guba & Lincoln, 2008).

In this present study, the researcher seeks to understand the lived experience of people (Year 12 chemistry teachers and students in Samoa) and their interactions in natural settings (within the chemistry classroom). According to Guba and Lincoln (2008), an interpretivist researcher enters the field of study with some sort of prior insight about the research topic but assumes that this is insufficient in developing fixed research design due to complex, multiple and unpredictable nature of what is perceived as reality. Thus, reality is not the fixed, single, agreed upon or measurable phenomenon that it is assumed to be in positivist, quantitative research designs (Merriam, 2009). It is the multiple constructions and interpretations of reality that qualitative researchers are interested in, in order to gain insight and understanding of the situation (Merriam, 2009). Such interpretations can only be understood as these multiple realities (Guba & Lincoln, 2008).

3.4 Research approach

This study seeks to use the experiences and perspectives of participants to inform understandings of supports for and barriers to students' achievements in Year 12 chemistry in Samoa. Several writers have identified a number of key features of qualitative research that are relevant to this study. These include the intentionality of the researcher to understand the meaning people have constructed about their world and their experiences, and the researcher being the primary tool for data collection and analysis. The product of such qualitative inquiry is richly descriptive and, frequently uses the participants own words and the quality of the research is judged using criteria for trustworthiness (Denzin & Lincoln, 2011; Teddlie & Tashakkori, 2011; Yin, 2009). Since the focus of the study is on understanding rather than explanation, the study is primarily qualitative with a small set of quantitative achievement data used for selecting a range of participants from the larger pool of students who volunteered to take part in the study.

Qualitative study lends itself to what is going on within a specific topic, as well as presenting a detailed view of the topic as it takes place in its natural settings (J. W Creswell, 2007). Whatever is being observed and studied is allowed to happen naturally (Denzin & Lincoln, 2011; Guba & Lincoln, 1998). The selection of a qualitative approach for this study ensures that it is a situated activity that locates the observer in the real world (Denzin & Lincoln, 2011). This enables the researcher to observe the workings of the case (Stake, 2005), and to understand the situations in their uniqueness (J. W Creswell, 2007), as part of a particular context and the interactions occurring within their real world (Denzin & Lincoln, 2011).

3.4.1 Case study methodology

The literature provides many types and forms of qualitative research approaches, for example, Creswell (2007) listed five, Patton (2002) identified sixteen, Tesch (1990) listed forty five, Denzin and Lincoln (2005) and Merriam (2009) listed six. Case study methodology is particularly appropriate to study human behaviour in the real world as it happens (Stake, 2005), especially when trying to understand people and the way they operate in specific situations and the meaning for those involved in real-life context (Merriam, 2009; Yin, 2009). This makes case study methodology particularly appropriate

for this study, especially as it involves not only the students and teachers but it also considers the surrounding influences (of the classroom).

Using a case study approach for this study involves the investigation of the issue within the context of its use (Yin, 2009), that is, within the situation in which the activity takes place and the information narrated by the research participants (Teddlie & Tashakkori, 2011). Such information often proves to be most valuable source in understanding complex phenomena. According to Teddlie and Tashakkori (2011) “narratives stories are intrinsically more interesting (and often more enlightening) than numbers to many researchers (p. 286). Thus, the detailed qualitative accounts produced in case studies not only help to explore the data in real-life environment, but also help to explain the complexities of real life situations which may not be captured or explored through experimental or survey research (Teddlie & Tashakkori, 2011).

Whilst a great deal of case study research focuses on a single case, the present study employs a multiple case study design. Multiple case studies, which Yin (2009) describes as analogous to multiple experiments enable the researcher to explore similarities and differences within and between cases. If the finding is replicated with different kinds of people and in different places, then the evidence suggest that the finding applies very broadly and the more confidence we can place on the finding (Johnson & Christensen, 2012). Using multiple case study design, Johnson and Christensen (2012) described that each case is usually first examined in total, and then the different cases are compared in a cross-case analysis for similarities (patterns that cut across the cases) as well as differences. Under these conditions, evidence from multiple case studies are considered to be more compelling and robust, although it requires greater resources and time (Merriam, 2009).

Yin (2009) suggests that case study approach is only successful when it is built on the collection and analysis of data from multiple sources. Potential data sources may include, but not be limited to, student achievement records, interview, observations and physical artifacts or work samples. In case study, data from these multiple sources are then converged in the analysis process rather than handled individually. In this regard, each data source may be viewed as one piece of the puzzle, with each piece contributing to the researcher’s understanding of the whole phenomenon. This convergence adds strength to

the findings as the various strands of data are braided together to promote greater understanding of the case and it assists in bringing a richness of data together through triangulation, and to enhance data credibility (Johnson & Christensen, 2012; Teddlie & Tashakkori, 2011; Yin, 2009).

Although the opportunity to gather data from various sources is extremely attractive because of the rigor that can be associated with case study approach, there are dangers. One of them is the collection of overwhelming amounts of data that require management and analysis (Johnson & Christensen, 2012). Rowley (2002) suggested that the “analysis of this rich resource is based on [exploring], categorising, comparing and tabulating evidence to assess whether the evidence supports or otherwise the initial propositions of the study” (p. 24). Often, researchers find themselves lost in the data. In order to bring some order to the data, a computerised database is often necessary to organise and manage the voluminous amount of data (Flick, 2009; Silverman, 2009). Such computerised database improves the reliability of the case study (Yin, 2009) as it enables the researcher to track and organise data including field notes, artefacts, narratives and audio files can be stored in a database for easy retrieval at a later date for coding (Flick, 2009; Silverman, 2009). The qualitative analysis software package known as *NVivo* was used as a database to facilitate and manage the complex, iterative process of analysing large amounts of qualitative data.

3.4.2 The various types of case studies

The purpose of case study research has three main classifications: descriptive, explanatory or exploratory (Yin, 2009). These are useful in providing answers to what how and why questions, and in this role can be used for descriptive, explanatory or exploratory research. A definition of each type will help identify the type of case study design essential for the current study.

Descriptive case study

A descriptive case study, according to Yin (2009), enables the researcher to fully illuminate the intricacies of an experience or the phenomenon within its context. It aims, primarily, at gathering complete knowledge and descriptions of the phenomenon under study. The researcher looks into a particular situation for its own sake, regardless of outside concern. The researcher becomes more interested in it because we need to learn about that

particular case. Stake (2005) refers to this as intrinsic case study, where the researcher has an intrinsic interest in the case. Descriptive case study research requires a theory to point data collection in the correct direction.

Explanatory case study

An explanatory case study, on the other hand, seeks to define how and or why an experience took place. The main purpose of these case studies is to suggest clues to possible cause-and-effect relationships (Yin, 2009). Because of this cause-and-effect relationship, Bassey (1999) described it as a ‘theory-testing’ deductive approach which primarily aims at gathering evidence to confirm or refute accepted theory. Because these studies sometimes suggest causality, they risk the chance of being challenged on the basis that one case does not make for a true experiment.

Exploratory

Finally, exploratory case study is a type of research conducted to explain a particular issue or phenomenon that has not been clearly defined (Yin, 2009). The focus is to document the issue as completely as possible rather than the case. Stake (2005) defines this type of case study as instrumental which involves using a case study to gain insights into a particular phenomenon, where there is also an explicit expectation that learning can be used to generalise or to develop theory.

Exploratory case study was chosen for the present study for two reasons. The first is based on the fact that the study seeks to explore the Year 12 chemistry classrooms in Samoa to develop an understanding of the teaching and learning processes, activities and interactions, in order to identify and explore the nature of supports for and barriers to students’ achievement. This is important because of the fact that there is no teaching and learning research in Samoan chemistry classrooms. Therefore this is researching new grounds particularly in the Samoan context. The second reason for choosing an exploratory case study is because existing theories fail to adequately explain the phenomenon (Yin, 2009), or they are inappropriate to the context. For example, the current study was conducted in Samoa, where the authority of tradition remains an important part of cultural practice. Theories that do not reflect such practices may be considered irrelevant not only to the study participants but also to the people of Samoa.

3.4.3 Ensuring quality of the study

To establish the integrity of qualitative research findings within the research, Guba and Lincoln (2008) and Creswell (2007) suggest four pillars of trustworthiness that need to be addressed: credibility, transferability, dependability and confirmability.

Credibility

Credibility in qualitative research, deals with establishing a phenomenon in a convincing manner that is called a 'generative mechanisms' or 'causal power' (Guba & Lincoln, 2008).

These assist in determining inferences about real-life experiences (Merriam, 2009).

However, these experiences “do not speak for themselves, [but] there is always an interpreter” who interprets and develops meaning to these naturally occurring experiences (J. W. Ratcliffe, 1983, p. 149). This interpretivist stance recognises multiple truths and has a core goal of understanding observed social phenomenon between the researcher and the participants. This is carried out through the use of audio recording of interviews, clarification of participant meaning by rephrasing during the interview in the form of rephrasing question or using probes; the provision of interview transcripts to participants to review, and the inclusion of descriptions from participants in the thesis. Credibility of the study is achieved by assessing the researcher's interpretation of the data (Charmaz, 2005) and whether the findings are credible, given the data presented (Lincoln & Guba, 1985). In the present study, credibility is addressed by the use of individual case analysis, cross-case analyses, pattern matching and also through triangulation of evidence.

Each individual case consists of a holistic study by itself, in which facts are gathered from various sources and conclusions drawn on those facts. Every case is unique and it must be explored thoroughly during the analysis, in order to reveal similarities and differences between the activities within. Teddlie and Tashakkori (2011) explained that “within-case analyses are qualitative analyses that are bounded within a single case ... where the data from cases are analysed one case at a time” (p. 406). Conversely, cross-case analyses are important to compare multiple cases, in many divergent ways, which is impossible within an individual case or a single case analysis (Teddlie & Tashakkori, 2011). In support of this notion, many studies have argued that cross-case analyses is particularly useful for searching patterns: that is, comparing cases against pre-defined categories, when in search of similarities and differences, or by classifying the data according to data sources (for

example; Denzin & Lincoln, 2011; Eisenhardt, 1989; Rallis & Rossman, 2011). These patterns are compared against each other, in order to determine whether they match (i.e. that they are the same), or they do not match (i.e. that they differ).

Transferability

Transferability is defined as the degree to which the research findings can be replicated beyond the proximate research case studies (Guba & Lincoln, 2008). Stake (2005) suggested that generalisation is not the purpose of the case study at all: its purpose is to become intimately aware of the inner workings of a particular phenomenon within its real context. Generalisations, therefore, are often formed by the readers, to decide whether the researcher has presented enough evidence to support any general statements that might have been made (Stake, 2005).

Dependability

Dependability emphasises the stability of the data over time. The researcher must be able to account for the permanently changing context in which the research takes place, describing any changes that occur and how these changes affect the research. It demonstrates that the inquiry is free of bias, values and prejudice, i.e., that the data interpretations and outcomes are rooted in contexts and people involved in the study (apart from the research) and are not mere products of the researcher's imagination (Denzin & Lincoln, 2011). This allows the possibility of multiple interpretations of reality by the research participants. A similar study with different participants or in a different institution with different organisation culture and context or by a different researcher may not necessarily yield the same results (Merriam, 2009).

Dependability in this study involved the development of case study procedures to identify the case study protocol and the establishment of a case study database (Merriam, 2009) for future researchers to access the files (Yin, 2009) and repeat the study. As such, an in-depth coverage of the research design is provided to allow the reader to assess the extent to which proper research practices have been followed. Also, the use of multiple methods of collecting data (method triangulation) is more likely to result in consistent and dependable data that is rich and complex about a phenomenon under investigation (L. Cohen & Manion, 2000). The study also used an audit trail, as described by Denzin and Lincoln

(2011), through the use of written field notes, the day’s activities noting the date, time and places, research procedure and personal notes about the factors that influence the data collection.

Confirmability

Confirmability is defined as the ability of others to satisfy themselves that the research was carried out in the way it is described by the researcher (Guba & Lincoln, 2008; Miles & Huberman, 1994). It concerns itself with the development of the internal coherence of the data in terms of findings, interpretations and recommendations (Guba & Lincoln, 2008). This can be accomplished using multiple sources of evidence, establishment of a chain of evidence; and ensuring that the participants review their interview transcripts. These can be used by someone else to confirm or contradict the findings of this study if they choose to (Lincoln & Guba, 1985).

The above four pillars are summarised in Table 3.1.

Table 3. 1: The strategies used to enhance research trustworthiness

<i>Strategies</i>	<i>Descriptions</i>
Triangulation	Multiple data sources and multiple methods of collection of data.
Participant language	Literal statements and quotations from the participants’ interviews are used in various areas of the thesis.
Mechanically recorded data	Interviews were audio recorded and transcribed
Participant review	Interview transcripts were delivered to participants for them to review and confirm what they said in the interviews.

3.5 Ethical principles

Ethical principles revolve around issues related to outweighing potential harm, privacy, anonymity and confidentiality and, protecting the rights and interests of participants (Berg, 2007). This section discusses ethical issues relating to this study that include voluntary and informed consent, privacy, anonymity and confidentiality, and, the rights of the participants.

3.5.1 Informed consent

Informed consent is an important ethical concept, which attempts to capture and be concerned with what is regarded as the appropriate relationships between the researcher and research participants (Bouma, 2004). It serves to protect the identities and privacy of the participants. Thus, the participants are aware that their names and identifying information, such as specific roles will not be used in any discussion or written documents about the research (Rallis & Rossman, 2011). Informed consent relates to potential research participants making voluntary choices about participation, based on sufficient knowledge and comprehension of the research, the risks and benefits of participation and their rights as participants (Berg, 2007).

Formal procedures for obtaining informed consent included an information sheet that explained the research investigation, the participants and researchers' roles as well as the participants' rights. The Samoan protocol concerning the manner in which to approach others was stated and adhered to before the information letters were given out. In this regard, the researcher first approached the teacher participants in person, then the potential student participants' (without the teachers). While talking about the intention of the research, the information sheets were given out and the potential participants were given the opportunity to discuss and ask questions in order to gain deeper understanding of the investigation and the processes involved.

3.5.2 Privacy, anonymity and confidentiality

When research takes place in real-life situations with real people who live and work in the setting then they are not anonymous to the researcher (Rallis & Rossman, 2011). However the researcher ensured that the confidentiality of the information and anonymity of the participants would be maintained through the removal of any identifying characteristics

throughout the data collection and before widespread dissemination of information (Babbie & Mouton, 2001). For instance, each participant was interviewed individually at different times to protect privacy from other participants as well as other students and teachers. The researcher made it clear that the participants' names would not be used for any other purposes, nor would information be shared that revealed their identity in any way.

3.5.3 Research participants' rights

For the most part, issues of ethics focus on establishing safeguards that protect the right of the participants (Bulmer, 2001) and an agreement from participants for the use of their data. To participate in this study the participants had the right to:

- know what the research was about
- decline to answer any particular question during the interview
- withdraw and remove any information they had contributed (classroom observations and interview) from the research investigation up until interview transcripts were finalised
- ask any question about the study at any time during participation
- provide information on the understanding that their names would not be used unless permission was provided to the researcher by the participant
- know who to contact with questions or concerns
- be given access to a summary of the project findings when it is concluded, and
- have the audio recording turned off at any time during the interviews.

In pre-research meetings, the information sheets which contain the criteria above, were clearly emphasised and participants were continuously reminded of their rights throughout the investigation. This is because in Samoa, children's rights to participate in any research are often hindered by cultural beliefs and customs. For example, students respect adults and visitors which include doing what is asked of them.

3.6 Contextual information of case study schools

A report from the Samoa Ministry of Finance (2006) shows that the population of Upolu Island (where the capital of Samoa is located) has been constantly increasing over a ten year

period, due to rural-urban migration. The reasons for this migration movement were mainly because youths and adults were seeking work opportunities and parents were seeking education for their children. One of the stimulating factors for this migration movement is the National University of Samoa (NUS), which offers a number of courses for secondary school graduates as well as adults. The NUS is located in the outskirts of Apia, the capital of Samoa. Thus, 76% of Samoa's total population are now living in Upolu and the urban areas are very densely populated (Ministry of Finance, 2006).

The number of students in Samoa's urban secondary schools is high and, therefore, the classes are often full. This is because students are selected from Year 8 from all over Samoa based on their national examination results, to gain entrance to these urban schools. Furthermore, there is a wide range of subjects available for students to choose, generally because in urban schools teachers are available to teach every subject as oppose to rural schools. In an effort to control the excess number of students in urban schools, MESC upgraded some rural secondary schools to offer Years 12 and 13, and will continue upgrading other schools. However, with the limited number of science and more specifically chemistry teachers in rural areas, the range of secondary subjects offered is also limited. For instance, four out of five urban secondary schools teach senior chemistry. On the other hand, only seven out of nineteen rural secondary schools teach chemistry in Year 12 with classes tending to be smaller.

Three government co-educational secondary schools were invited to participate in this research and agreed to do so. Two secondary schools from the urban area are identified as School 1 (S1) and School 2 (S2) and one from the rural area is identified as School 3 (S3), in the present study. One chemistry classroom from each of the three schools is identified as Case Study 1, 2 and 3 (e.g., CS1, CS2 CS3) respectively.

All three selected secondary schools are managed by MESC including the recruitment of teachers and their salaries; the supply of stationery; curriculum materials; assessment and examinations; and teacher in-service training. Like many rural schools, S3 has a school committee (or a governing body) made up of members from the schools' local community and the school principal. They are expected to fund all other operating costs, such as furniture and equipment, and maintenance of schools and their environment from school

fees and fund-raising activities. Schools 1 and 2 are fully funded by the government. School buildings and other school facilities are funded by the government through the MESC.

3.6.1 About School 1 (S1)

The first school (S1) was an urban secondary school. For many years S1 has been teaching science subjects (such as biology, chemistry, physics and agricultural science) and they were offered in Years 9 to 13. At the time of the study, there was only one Year 12 chemistry class, which was made up of ten students (four males and six females). This is Case Study 1 (CS1).

The student participants from Case Study 1 (CS1)

Out of ten students in the class, nine indicated in their consent forms (Appendix F) that they were happy to take part, although the researcher was only looking for five students and one teacher participant from each case. In order to obtain a satisfactory representation across the range of student achievement, five participants were selected using the previous year (2009) science examination results of the potential student participants who agreed to participate. The results from 2009 were used because there was no chemistry achievement record available for the students in the Year 12 chemistry class. In order to maintain the privacy of the student and teacher participants in the present study, pseudonyms are used. Table 3.2 shows demographic information for CS1 student participants.

Table 3. 2: Demographic information for CS1 student participants

<i>Pseudonyms of student participants</i>	<i>Gender</i>	<i>Achievement data 2009</i>
Raylene	F	95
Ruth	F	80
Simeona	M	76
Losi	M	70
Janine	F	57

The teacher participant from Case Study 1 (CS1)

Malaki (pseudonym) has taught for 2 years in S1, first as a science teacher and then as a chemistry teacher. He has been heavily involved in marking Years 12 and 13 chemistry papers for the national examination, as well as in the development of the current senior chemistry curriculum.

3.6.2 About School 2 (S2)

S2 was also an urban secondary school which offered a variety of subjects ranging from arts, commerce and science. At senior levels (Years 12 and 13), these areas are offered in various disciplines. For example, science disciplines include biology, physics and chemistry. At the time of this study, two chemistry classes for Year 12 were being offered, due to the high number of students opting for this subject. Each class had its own chemistry teacher. After pre-research meetings with the two chemistry teachers, one consented to participate and gave permission for the researcher to work with her class. This class was made up of thirty one students (nineteen females and twelve males) and was identified as Case Study 2 (CS2).

The student participants from Case Study 2 (CS2)

Upon the return of the students' consent forms, a total of 17 students agreed to participate in the study. The method used in S1 was also used to select five student participants for CS2 across the range of science achievement. Student participants are identified in pseudonyms in Table 3.3.

Table 3. 3: Demographic information for CS2 student participants

<i>Pseudonyms of student participants</i>	<i>Gender</i>	<i>Achievement data 2009</i>
Sam	M	92
Valeni	M	81
Florence	F	70
Joyce	F	62
May	F	55

The teacher participant from Case Study 2 (CS2)

Eileen (pseudonym) has taught chemistry in S2 for two years after graduating from the National University of Samoa.

3.6.3 About School 3 (S3)

The third case study school, S3, is a rural secondary school in Upolu. The range of subjects offered in S3 is dependent on the availability of teachers. In science, for instance, chemistry has been offered for six years by the same teacher. At the time of the study, only one Year 12 chemistry class consisting of nine students (two males and seven females) was available, which made up Case Study 3 (CS3).

The student participants from Case Study 3 (CS3)

Nine students gave consent and demonstrated enthusiasm to participate in the study. The same approach used in S1 and S2 was used to identify five student participants in S3 across the range of science achievement. Pseudonyms were used to ensure privacy of the student participants listed in Table 3.4 below.

Table 3. 4: Demographic information for CS3 student participants

<i>Pseudonyms of student participants</i>	<i>Gender</i>	<i>Achievement data 2009</i>
Malia	F	60
Tiana	F	55
Mary	F	43
Dianne	F	31
Tamatoa	M	29

The teacher participant from Case Study 3 (CS3)

Fono (pseudonym) has been teaching chemistry for eleven years with five years in a different school and six in S3. He has been involved in marking SSC chemistry examination

as well visiting schools in order to verify the teachers' internal assessment (IA) programmes for Year 12 chemistry.

3.7 Methods of data collection

As the study seeks to understand the nature of factors contributing to students' achievement in Year 12 chemistry in Samoa, multiple sources of information were used (Yin, 2009), because no single source of information could be trusted to provide a comprehensive perspective (Patton, 2002) of a phenomenon. The present study employed a range of data collection techniques some of which were specific for groups of participants as shown in Table 3.5.

Table 3. 5: Data collection techniques and research participants

<i>Research questions</i>	<i>Data collection techniques</i>	<i>Student participants</i>	<i>Teacher Participants</i>
Question 1: What factors support achievement in Year 12 chemistry classrooms in Samoa?	Achievement records	√	-
	Classroom observations		
	Work samples	√	√
	Semi-structured interviews	√	-
		√	√
Question 2: What are the natures of barriers to achievement in Year 12 chemistry in Samoa?	Achievement records	√	-
	Classroom observations		
	Work samples	√	√
	Semi-structured interviews	√	-
		√	√

3.7.1 Student achievement records

As proposed by O'Toole and Cox (2006), achievement records designate all collection of written records. In Samoa, individual schools keep records of students' achievement in each subject they learn while at school. These records are later used to classify students in terms of their achievements as they move to the next level. Information from achievement

records was used to select student participants who represent a range of achievements across the whole class. However, at the start of the study there was no chemistry achievement record available for the students in the Year 12 chemistry class, so the science achievements from the end of 2009 of the potential student participants who agreed to participate were collected.

3.7.2 Classroom observations

Methodological discussions about the role of observation as a research method have been central to the history of qualitative research (Flick, 2002). Observation is one of the oldest and most frequently employed techniques for collecting data in the field of educational and social research. It is also employed in the framework of quantitative research. Observation assumes the presence of the observer in a particular situation and collecting data about the happening in the setting under study. The crucial research instrument is the observer, who collects data mostly by means of his or her sight (Sarantakos, 2005), but also through other senses.

In comparison with the other techniques of collecting data, the main advantages of the observation technique are that: it allows direct collecting of data since the observer sits in the situation under study; data are collected in the natural setting, it permits the observer to acquire data which cannot be obtained with other techniques, and it allows people to verify the validity of responses using interviews since by observing the situation one can find out whether people do as they say (Bryman, 2004).

This study involved non-participant classroom observation of some lessons taught by the teacher participants in each of the three cases using a loosely structured observation protocol. The protocol had a list of key aspects that were considered useful for the present study. The aspects of interest were: (i) teaching and learning strategies; (ii) classroom participations; and (iii) learning tasks. Under each aspect, several key elements were listed as shown in Table 3.6 below. A unit from the organic chemistry strand was selected for observation in all cases. This selection occurred because all the three teacher participants were teaching the same unit (at the time of the study) and all agreed to the observation.

Table 3. 6: Proposed aspects of interest during classroom observation

<i>Teaching and learning strategies</i>	<i>Classroom participations</i>	<i>Learning tasks</i>
Questions & answers	Voice & language use	Purposes
Explanations	Eye contact	Quantity of tasks
Demonstrations	Attentive	Students' reactions towards
Language instruction/writing	Relationship with all students	
Activities/types	Frequency of responses	
	Reactions to asking or answering questions	

3.7.3 Student participant work samples

A sample of each student's work/activity in classroom was collected and explored. While Searle (2003) criticised the use of a work sample in classroom teaching, these types of activities are commonly used by the teachers in secondary schools to test and practise skills in solving algorithmic problems in class. In this regard, these types of activities can be viewed as a means of evaluation of students' learning. For this reason, work samples can be used as evidence of students' achievements or difficulties they encountered.

With the limited range of tasks implemented at the time of the study, a sample was chosen randomly from short classroom tasks/activities, notes and home tasks/activities. These tasks was developed by individual teachers for their own students, therefore, the sample of work collected were different for each of the three cases. Most of the work samples collected had already been assessed by the chemistry teachers, except for a few that were not assessed. Various explanations were revealed by the research participants concerning these non-assessed tasks during the interview sessions.

3.7.4 Research participants' semi-structured interviews

This technique involves data collection through direct verbal interaction between the researcher and the research participant. It allows the researcher to gain insights into participants' perspectives on the phenomenon under study. It is particularly useful, in order to ascertain the participants' thoughts, perceptions, feelings and retrospective accounts of

events (Rallis & Rossman, 2011), since these could not be directly observed (Merriam, 2009; Patton, 2002). Due to the nature of this tool, it allows new questions to be introduced and offers opportunities to probe deeper into the “situation at hand, to the emerging worldview of the participants and to new ideas on the topic” (Merriam, 2009, p. 90). Many researchers use observations together with interviews to cross-check issues under study as well as to capture data that can otherwise not be collected through other collection techniques.

One of the main ingredients of interview is listening or being very attentive to what the interviewee is saying or even not saying. It means that the interviewer is active without being too intrusive (Denzin & Lincoln, 2005). But it also means that just because the interview is being audio recorded, the interviewer cannot take things easy. In fact, an interviewer must be very attuned and responsive to what the interviewee is saying and doing (Merriam, 2009). This is also important because something like body language may indicate that the interviewee is becoming uneasy or anxious about the line of questioning (Draper & Swift, 2011; Tufford & Newman, 2012). An ethically sensitive interviewer will not want to place undue pressure on the person they are talking to and will need to be prepared to cut short that line of questioning if it is clearly a source of concern (Merriam, 2009).

In the present study, a semi-structured interview for all participants were preceded by classroom observations, collection of work samples and achievement records (Bernard, 1988). Such a system of data collection captures data that otherwise may not be collected through observation and work samples alone. In addition, it enhances the exploration of relevant ideas revealed prior to the instruction of semi-structured interviews. Samples of the interview guiding questions for teachers and students are given in Appendices I and J respectively.

3.7.5 Identifier for methods of data collection

The methods of data collection and how they are identified in this study is presented in Table 3.7. These identifiers are used with the pseudonyms (see Table 3.8) to identify each participant in the study.

Table 3. 7: Identifier for methods of data collection

<i>Method of Data Collection</i>	<i>Identifier</i>
Classroom Observation Field Notes 1	COFN ₁
Classroom Observation Field Notes 2	COFN ₂
Classroom Observation Field Notes 3	COFN ₃
Work Sample 1	WS ₁
Work Sample 2	WS ₂
Work Sample 3	WS ₃
Interview	Int

Table 3. 8: Identifier for participants with method of data collection

<i>Identifier</i>	<i>Pseudonyms</i>	<i>Type</i>	<i>Quotation identification</i>
CS ₁ S ₁ WS ₁	Losi	Student	
CS ₁ S ₂	Simeona	Student	<i>Losi-CS₁S₁WS₁ where Losi is from Case Study 1 Student 1</i>
CS ₁ S ₃	Janine	Student	<i>Work Sample 1</i>
CS ₁ S ₄	Raylene	Student	
CS ₁ S ₅	Ruth	Student	
CS ₂ S ₁	Sam	Student	
CS ₂ S ₂	Valeni	Student	
CS ₂ S ₃	Florence	Student	
CS ₂ S ₄	Joyce	Student	<i>Eileen-CS₂TInt where Eileen is from Case Study 2 Teacher</i>
CS ₂ S ₅	May	Student	<i>Interview</i>
CS ₃ S ₁	Malia	Student	
CS ₃ S ₂	Tiana	Student	
CS ₃ S ₃	Mary	Student	
CS ₃ S ₄	Dianne	Student	
CS ₃ S ₅	Tamatoa	Student	
CS ₁ T	Malaki	Teacher	
CS ₂ TInt	Eileen	Teacher	
CS ₃ T	Fono	Teacher	

3.8 Research procedures

This section describes the various events involved in the research process, with a specific focus on the data collection phase.

3.8.1 Seeking ethical approval

Prior to approaching the CEO for the Samoan MESC for permission to contact case study schools, an ethics application was submitted to the University Ethics Committee. Approval was given by the Massey University Human Ethics Committee: Southern A, Application 09/56 (Appendix M).

3.8.2 Approaching MESC's CEO

The Samoan Government, in recent years, has implemented a new approval process for all research conducted in the country by people and agencies from outside it. For any research to be conducted in Samoa, permission from government ministries, in which the research is to be carried out, must be endorsed by the CEO of the Ministry beforehand (Ministry of Education Sports and Culture, 2006a).

An application outlining the research was sent to the CEO of the MESC (Appendix A). Permission to conduct the research in three government secondary schools was granted and confirmation from the CEO was received together with the following conditions:

- (i) A copy of the full research proposal was to be sent to the MESC for their records.
- (ii) A list to be submitted of all MESC documents and personnel or data that may be required.
- (iii) An outline of how the researcher proposed to use the findings and who would have access to the findings.
- (iv) Notification of whether the findings would be available to the general public.

In agreeing to the conditions and the guidelines provided, the researcher was asked to complete and sign an agreement form and return to the Ministry prior to the start of the study.

3.8.3 Approaching the principals of the three schools

Included in the letter from the CEO was the permission (Appendix N) to contact the three government secondary schools' principals and to provide them with the information about the study. While on site, meetings were organised in order to meet with and seek permissions from individual principals of the three case study schools prior to the start of the study, and delivered the formal invitation letter (Appendix B). Critical in this letter was the inclusion of the approval from the CEO. The letter outlines the purpose, procedures, duration and requirements of the research study as well as information on the rights of the teachers and student participants. A brief discussion to provide further explanation followed which emphasised the contribution sought from Year 12 chemistry teachers and students and their rights as research participants. It was also important to reiterate that the identity of the participants and schools would remain confidential throughout the research and in any future publication or presentation of the research findings. Individual principals were satisfied with the information and the researcher was invited to arrange meetings with the Year 12 chemistry teachers and students.

3.8.4 Inviting Year 12 chemistry teachers

The next set of meetings was with individual Year 12 chemistry teachers from each of the three cases. Generally, there is only one chemistry teacher in each of the case study schools. However, S2 had two teachers. The meetings were conducted during a non-teaching period. The teachers appeared to have some knowledge of the research; perhaps this had come from their principals. Despite this fact, the teachers were formally invited to take part in this study and were given the information sheets (Appendix C) (available only in the English language) which explained the purpose, procedure, duration and requirements of the research study. Questions and comments from individual teachers were clarified and their rights, as voluntary participants, were clearly identified.

Consent forms (Appendix D) were given out when there was no further comments from the teachers, and they indicated that they understood the information provided in the information sheets. All teachers completed and returned the consent forms on the same day and the only one teacher from S2 volunteered to participate in this study.

3.8.5 Inviting Year 12 chemistry students

Prior to meeting the Year 12 chemistry students, permission from the chemistry teachers were obtained to approach students in their class. Meetings were scheduled in the last fifteen minutes of their chemistry classes. In a Samoan community, young peoples' decision-making is very much influenced by an adult member of the family, or an adult closely related to or important to them (such as a teacher), and the young person's decision would be driven by the facial expressions of the adult. Taking this tradition into account, the teachers were asked to leave the classroom before the meetings with the students began to avoid students feeling any pressure. The researcher introduced himself as a student who is seeking information from them for education purposes.

In each case study school the students were give the opportunity to choose the language that they would prefer to use in our meetings. Thus Samoan language was used, except in S2, where most of the students were *afakasi* (mixed race). At each class meeting, an initial introduction of the researcher was given together with a brief account of the study in the language (Samoan or English) that the students preferred. The students were invited to ask questions whenever possible. The information sheets (Appendix E) which included the purpose, procedure, duration and requirements of the study as well as their rights as participants were given to the students when they had no further questions.

Similar to the teachers, the students preferred to listen to the verbal explanation rather than read the information sheets. To ensure that the students understood all the information provided, they were given some time to look and talk through the information sheets in their preferred language. This is because the information sheets were written in English language. Questions and comments from the students were clarified and their rights, as voluntary participants, were clearly identified. In each individual case study school, once students indicated that they had understood the information, they were provided with the consent forms. The students were allowed to take the form home to think over whether to participate in the study, complete it, and return it the next day. A drop-in box was placed in the chemistry classroom for everyone to return their forms indicating whether they agreed or not to take part in the study. The researcher also reminded all chemistry students not to talk to anyone with regards to the research investigation, or the researcher being in the school, in order to maintain confidentiality and privacy.

3.8.6 Communicating with participants

The use of mobile phones to contact teacher participants was effective. This method was used mainly to arrange meeting times and to confirm the teachers' availability.

Unfortunately many of the scheduled classroom observations or interviews were postponed as a result of the teachers being sent to workshops without earlier notification. At other times, the principal rescheduled the day's programme, due to sports or cultural activities (such as cultural dancing, food preparation and speeches), or a high number of teachers attending workshops. Therefore, pre-arranged times for classroom observations and interviews were not always guaranteed.

Notices for student participants, relating to meeting dates, location and time were displayed on the chemistry notice board. These notice boards were located in front of the lab or the library. Identifying number codes were used during the investigation in the notices in order to maintain the confidentiality of each individual participant, particularly students, since these notices were displayed in public places in the school.

3.8.7 Familiarisation visits to the three case study classrooms

Participants were informed about familiarisation visits and their purpose beforehand. Each class was visited three times, to ensure that the participants were familiar with the presence of the researcher. In a context, such as Samoa, people become easily affected in the presence of an unfamiliar person, which results in a change of behaviour and a loss of concentration. In a classroom context, students were often reminded of 'showing respect' in the presence of a visitor and in particular this affected the researcher due to being identified as a visiting scholar. Respect included keeping noise at a minimum level at all times, except during class discussions. Initially students turned and looked in the direction where the researcher was sitting, before responding to their teacher's questions. However, this behaviour reduced as the researcher continued with familiarisation visits. Students who made noises would be stopped by other students and then reminded of their good manners in respect of the visiting researcher in their classroom.

Samoan teachers are often fearful about the presence of an unfamiliar person in their classrooms and alter their behaviour as a result. When they feel uncomfortable they try to avoid being observed for a long period and do everything they can to avoid being criticised.

In order to avoid all these actions and changes, the researcher continued visiting the classrooms, to ensure that the teacher and student participants' behaviour in each case became more normal.

3.8.8 Data collection

Searching for achievement records began once consent had been given. Data collection involving participants started at the end of the familiarisation visits. Written schedules for the observations and interviews were prepared and handed out to individual participants as guidelines. Although the participants were informed of the procedures, the data collection was sufficiently flexible to accommodate what was happening in the schools, at the time of the research, in addition to the data collection itself. For example, S2 was heavily involved in preparation for their cultural day activities during the research investigation. Class sessions were often cut short in order to make time for practise and preparations. On these particular days, the researcher continued working in the other two schools.

The sequence of data collection was designed as follows:

- collect prior science achievement of student participants
- conduct classroom observations
- collect student participants' work samples and
- semi-structured interviews with student and teacher participants..

Collecting achievement records from student participants

Upon agreeing to participate, these students were given letters to seek permission to access their achievement records (Appendix G). The information was available at the school admission records. Accessing the school records (Appendix H) was straightforward, since the researcher was given full permission by each of the three school principals to seek the required information from their archives.

Classroom observations

In each case, three observations were carried out during the implementation of a unit on hydrocarbons in the organic chemistry strand. This unit was selected for this study because all three schools were teaching it at the time of the investigation. Field notes were taken throughout the observations. The researcher sat at the back of the classroom, making no

attempt to interact with (or influence) the participants. Teacher and student participants were observed, whilst they participated in class discussion, individual work and throughout the chemistry lesson.

Collecting work samples from student participants

During some observed lessons, the teachers gave out tasks for students to complete, either in class, in their own time, or at home. These tasks included copying notes, answering short or long type questions, calculations and drawing diagrammatical representations of molecules. Apart from the notes, copies of all other types of tasks were collected for assessment by their teacher.

The student participants were asked for permission to collect a random sample of these tasks for analysis. These tasks were carried out during the teaching of organic chemistry strand. Since the tasks were done in exercise books, the researcher collected the class exercise books, made photocopies of the student participants' work sample and returned them to the students before the next chemistry class.

Semi-structured interview of all research participants

Interviews were arranged in order that there were no disruptions to the teachers' teaching times as well as the students' classes. Class schedules for individual participants were collected to facilitate this arrangement. Student participants' interview sessions were arranged with the individual student at different times throughout the week. These interviews were conducted during their free periods. A room that students do not normally have access to was made available for individual student participants' interviews. The door remained half-opened during the interview sessions to ensure that the student participants felt comfortable in the room with a male researcher.

The teachers were involved in meetings and workshops during school hours, for long periods of time. Notwithstanding the amount of extra-curricular activities allocated to the teachers, they still had to ensure that tasks were prepared for their classes. With this in mind, the teachers were given the opportunity to choose the time and location of their interviews. They were clearly informed that interviews sessions were to be confined within school hours and they would be conducted within the school grounds.

All interviews were audio recorded. Prior to the start of each interview session, the participants were reminded about the recording and their right to stop it at any time. As a result of classroom observations, it was realised that some students appeared to have limited English language competency. Due to these observations, the student participants were invited to choose their preferred language for the interview. Samoan was chosen by the majority of student participants, (with a mixture of English and Samoan in some of their responses) except three from CS2 (Sam, May and Joyce). Teachers' responses to the interviews were a mixture of English language and Samoan.

Interviews were scheduled after the teaching of the selected unit on hydrocarbons in the organic chemistry strand. Each student participant was interviewed for approximately 40 minutes during a free period. This was scheduled to accommodate the 50 minutes duration of each class. Each teacher participant was interviewed for 40-60 minutes – when not teaching any classes. Although the participants were notified in advance regarding the time of their interview, there were still a few who did not turn up. Some simply forgot the scheduled time and some were absent from school on that particular day. In these cases, the interviews were rescheduled.

When all data collection was completed a light lunch was provided for each class as thanks for their participation in the study. In order to maintain the privacy of each participant, the school principal and all the Year 12 students and teachers in the case study classes were invited (not just the participants).

Returning transcripts to research participants

Verbatim transcripts for the individual interviews were prepared for verification by the participants. Whilst in the research sites the researcher realised that not all participants could gain access to the Internet. In fact, S1 was connected to the Internet but only the principal's secretary could gain access, whilst no access was available at S3. Returning transcripts to the participants through the postal service raised some ethical issues. The researcher was more conscious that the identity of student participants would be revealed to teachers and other students, if the postal service was used, or the contents of the transcripts could be revealed to their family if the transcripts were sent to family Post Office boxes.

The only option was for the researcher to travel to Samoa and deliver the transcripts to the individual participants. Meetings were arranged with each participant individually. At each meeting, the purpose of the second trip was explained and the transcript was given to the participant. The participants were invited to verify the information contained in the transcripts, and to provide further exploration if necessary. In the meeting, each participant chose the day and time to meet in order for them to return their transcript, which was scheduled for approximately a week later.

When the participants returned the transcripts, the majority of the student participants, who had made changes, would begin by telling what they had done on specific pages and gave reasons for wanting the particular information changed. A few student participants stated that they made changes but were unable to give explanations at the time. For those who did not wish to give explanations based on what they changed, they were asked few questions as a guide to reveal the reasons behind the changes they had made to their transcripts. In addition, a few questions were asked to confirm some ideas from some of the student participants. An authority to release the transcript (Appendix L) was then signed and returned to the researcher.

When meeting with individual teacher participants as they returned their transcripts, it was apparent that their envelopes remained unopened (still sealed). However, the aim was not to put pressure on them to read or make changes to their transcripts, but to give them the opportunity to ensure they were satisfied with what they answered to the interview questions. The three teacher participants, Malaki, Eileen and Fono, indicated that they were satisfied and that all that was written was solely what they intended to say. An authority to release the transcript (Appendix K) was then signed and returned to the researcher.

A summary of the research procedures is shown in Table 3.9.

Table 3. 9: A summary the research procedures

<i>Research process</i>	<i>Dates</i>	<i>Events</i>
Ethical Approval	October 2009	MUHEC Approval Southern : Application 09/56
Seeking permission from CEO	November 2009	CEO Approval Letter
On site pre-research Meetings	End of February 2010 – beginning of March 2010	Meet school principals & HOD Science Meet chemistry teacher Meet Year 12 students
Familiarisation visits	Mid-March 2010	Sit in chemistry class to develop rapport
Data collection	End of March 2010 – mid-May 2010	Collect student participants' achievement records Conduct classroom observations Collect student participants' work samples Conduct participants' semi-structured interviews
Return of transcripts	End of July 2010 – end August 2010	Meet participants individually and deliver transcripts for review Meet participants individually to return transcripts

3.9 Data analyses

Yin (2009) suggests that good qualitative case analysis adheres to the following four principles:

1. The analysis makes use of all of the relevant data.
2. The analysis considers all of the major rival interpretations, and explores each of them in turn.
3. The analysis should address the most significant aspect of the case study.
4. The analysis should draw on the researcher's prior expert knowledge in the area of case study, but in an unbiased and objective manner.

Drawing upon the above principles the analysis of the data ensures that trustworthiness of the findings is demonstrated. Like much of qualitative research, the analytical process begins during data collection as the observation data led to refinements in the interview

schedules. This sequential analysis has the advantage of allowing the researcher to go back and refine questions and pursue emerging avenues of inquiry in further depth.

Patton (2002) suggests a case study construction which is used in this study (Table 3.10) in three different stages. Following Patton's suggestion, all raw data were assembled and imported into the *NVivo* programme in the stage one. The data was organised and managed into folders created specifically to accommodate the data from the different data sources used in the study which eventually developed into a case study database for individual case. Using CS1 to demonstrate this data management in the *NVivo* programme, the student participants' folder was created to store classroom observation field notes, interview transcripts and work samples. A folder for teacher participant was also created to import data from classroom observation field notes and interview transcripts. Rowley (2002) suggests that "data analysis of this rich resource is based on examining, categorising, comparing and tabulating evidence to assess whether the evidence supports or otherwise the initial propositions of the study" (p. 24).

Data analysis began with the interviews as these represented rich sources of data and because some of the responses in the interviews described some of their reactions in the observed lessons and participation in learning activities. Analysis of all qualitative data for CS1 was undertaken first, then CS2 to be followed by CS3. The stages of data analysis are shown in Table 3.10.

After assembling the data in electronic folders (see stage one, Table 3.10) data analysis in stage two (Table 3.10) began by coding the data. This was a way to identify all references (for example from classroom observations, interviews, and work samples) to a specific topic and possible range of codes needed to identify initial themes relevant to the aim of the study. This process involves reading and re-reading all the information collected in order to get a sense of breadth of responses (Bogdan & Biklen, 2007). The overall idea is to become intimately familiar with each case (Stake, 2005) and be able to assign ideas or themes which are placed as nodes. The coded pieces of information were organised and placed at relevant themes or nodes. Some of the coded information identified was related to other themes and therefore they could be coded to one or more nodes. This process allows the unique patterns of individual case (e.g., in CS1) to emerge before patterns are

compared across other cases (CS2 and CS3). It is a fact that, with the “staggering volume of data” at this phase is an overwhelmingly important process while attempting to “cope with this deluge of data” (Eisenhardt, 1989, p. 540).

Table 3. 10: Summary of the case study construction (Adated from Patton, 2002)

<i>Stage</i>	<i>Details</i>
ONE	<p>Assemble raw case data into folders</p> <p>information about individual cases</p> <p>information about the participants</p> <p>information from achievement records</p> <p>information from classroom observations</p> <p>information from work samples</p> <p>information from semi-structured interviews</p> <p>enter all qualitative data into NVivo programme – individual case study folder</p>
TWO	<p>Organise, classify data</p> <p>using NVivo to code the qualitative data for each case</p> <p>using NVivo to create links between codes – individual each case</p> <p>develop patterns, themes & attributes – individual each case</p> <p>identify related themes – individual each case</p> <p>comparing cases seeking for further patterns, similarities and differences – cross case analyses</p>
THREE	<p>Write case study narrative</p> <p>writing the report based on the findings of the research</p>

The cross-case analysis is used for searching patterns, similar of distinctive ones across the three case studies. The goal is to go beyond the initial impressions by using structured and diverse lenses to explore further into the data. As a result, the likelihood of achieving reliable themes is improved. This can allow the “collection of comprehensive, systematic, and in-depth information about cases of interest even though they are placed in different settings” (Patton, 2002, p. 447). Patton’s viewpoints of cross-case analysis are important in this study to enable the exploration and interpretation of supports for and barriers to students’ achievements within and across the three cases.

Writing case study narratives as illustrated in stage three (Table 3.10) began once the key findings from individual case and cross cases had been finalised. Key findings and the results for each case study are presented and discussed in Chapters 4, 5 and 6. Then, the

key findings from the cross case analysis are presented and discussed in Chapter 7 where the discussion highlights the meanings of the key findings in terms of the aim of the study, and demonstrates how the findings fit within the body of literature related to the area of study.

The writing of the case study report was conceptually linked back to the case study raw data, through a chain of evidence. This allows the reader (or another researcher) to question or even re-interpret the data, if necessary. Allowing the reader to successfully check the chain of evidence increases the reliability of the case study. According to Yin (2009), a chain of evidence is established from the beginning of the research questions, through the data collection and on to the final conclusions.

3.10 Chapter summary

This chapter has provided justifications for the choice and use of a qualitative case study approach. A case study approach explores “multiple bounded systems (cases) through detailed, in-depth data collection involving multiple sources of information (John W. Creswell, et al., 2007, p. 245). Moreover, a case study is a particularly appropriate way to study human behaviour in the real world as it happens (Stake, 2005), especially when trying to understand people and the way they operate in specific situations and the meaning for those involved in real-life context (Merriam, 2009; Yin, 2009). Under the above conditions a case study approach was selected in order to explore supports for and barriers to students’ achievements in Year 12 chemistry in Samoa. Qualitative data collection methods adopted in this study include interviewing, observing and examining of work samples not only allowed for an holistic interpretation of the phenomenon being investigated, but also enabled the researcher to validate and cross-check findings. Several strategies used to enhance the trustworthiness of the research design, such as the use of the participants’ own words: mechanically recorded data, and the participants’ review, were incorporated into the study.

The research was given approval by the Massey University Human Ethics Committee, and the CEO of the Ministry of Education, Sports and Culture endorsed the research to be carried out in Samoa government schools. Thus, this study was conducted in accordance with the formal procedures for obtaining consent, ensuring privacy, confidentiality and

maintenance of anonymity for the research participants, and research schools were accounted for.

The chapter also provides contextual information about the case study schools and classrooms, the research participants and the procedures in which the research investigation followed from seeking ethical approval to data collection. A few familiarisation visits into the class before data collection was organised to ensure that the participants were familiar with the presence of the researcher and establish rapport. Finally in this chapter, a discussion relating to how the data was analysed and organised, so that key findings in each case and relevant themes across the three cases were developed was provided. The key findings from individual case-analyses (CS1, CS2 and CS3) were identified and are illustrated in Chapters 4, 5, and 6 (respectively). The themes developed from the cross case-analysis are discussed in Chapter 7.

Chapter 4 Case Study 1 Results

4.1 Introduction

In this chapter the results for Case Study 1 (CS1) are presented and discussed. It begins with a brief description of the case, followed by the presentation of results based on four key findings. The four key findings developed from the analysis of the data from CS1, summarise evidence relating to supports and barriers for chemistry learning and achievements in this class. They concern:

- The languages used in the chemistry classroom.
- Copying notes from handouts.
- Choosing chemistry for future careers.
- *Ole vā male faia'oga*—respecting the teacher.

Each key finding is supported with examples from the data collected (from the participants' interviews, classroom observations and students' work samples) including a brief discussion of key ideas in relation to the literature. Direct Samoan quotes from the participants are used throughout the chapter to avoid mistranslation of their responses. Literal translations are provided after each comment.

4.2 Description of Case Study 1 (CS1)

CS1 was a Year 12 chemistry classroom in School 1 (S1), an urban secondary school in Upolu, the main island of Samoa. At the time of the study, there was one Year 12 chemistry class, which was made up of 10 students (four males and six females).

Qualitative data collection in CS1 (and in all of the three case studies) included classroom observations, student work samples and interviews. The three observed lessons were guided by specific objectives taken from the Year 12 chemistry prescription document. Included in this document are the learning outcomes expected from students. It is used by teachers and School Certificate examiners to assess Year 12 students. Each student had a copy of the whole prescription. The objectives that the teacher participant kept referring to in the three observed lessons respectively were:

3.2 to investigate the sources of the naturally occurring hydrocarbons;

3.7 to list the physical properties of the alkanes; [and],

3.9 to list the physical properties of the alkynes.

Each chemistry class was scheduled for 50 minutes although the teacher arrived late for each of the three lessons observed. The three lessons followed very similar procedures which included the teacher: (i) giving an explanation based on the notes that s/he prepared; (ii) writing further illustrations and examples on the board; (iii) asking questions of students about what had been discussed; and, finally, (iv) instructing students to copy notes or to do a written task. The lessons were taught in English, except for a few times when the teacher used Samoan language for several reasons as discussed in section 4.3.

4.3 Languages used in the chemistry classroom

The findings in CS1 showed that English language was predominantly used in the teaching of chemistry. This was considered a support by the teacher Malaki and some of the students because it is the language used in SSC examination. There are also areas where the students found the use of English language as a barrier when they could not understand a question of a chemistry concept.

At secondary school level in Samoa, English is the sole medium of instruction in teaching and learning except in the Samoan language class (Ministry of Education Sports and Culture, 2006c). English is widely used in jobs and the media and its importance is further emphasised because students are examined in this language. It has officially “become the language of access to educational opportunities and subsequent economic choices” (Ministry of Education Sports and Culture, 2006c, p. 34), as well as a vehicle for communication and administration in schools and the workforce in Samoa. However, it is a second language to the Samoans. For example, in the interview Malaki acknowledged that the students were struggling:

I talked to the students and told them not to worry, it is not our language; just say whatever comes, let it out and don't think as if you're saying something wrong or what; we are Samoans, it is our second language ... they have to or else they will face problems in the exam and in the future (Malaki-CS, TInt).

Despite recognising the difficulties that students were going through with the use of the English language, Malaki continued using it to teach chemistry:

I use English when asking [questions] and rephrasing, giving hints and examples, I need them to practise hearing and speaking in English in order to become better, so it is important for me to continue (Malaki-CS₁TIInt).

In Samoan secondary school science, the “students are expected to use English to reason through to conclusions, read and understand expository texts, develop arguments, analyse, synthesise and evaluate ideas” (Ministry of Education Sports and Culture, 2004, p. 18). In this regard, the use of English language in the chemistry classroom is important. Student Raylene confirmed in the interview that:

I use English ... the teacher asks me to use it, then I try to give the answer in English and it's okay ... I know he wants us to practise [speaking] in English (Raylene-CS₁S₄Int).

Related to Raylene’s comment on the use of English, student Ruth stated in the interview that English:

... was not that hard ... most of the things he says in class I understand ... I just have to pay attention (Ruth-CS₁S₅Int).

As opposed to the viewpoints from Raylene and Ruth, students Losi and Simeona seemed to experience difficulties with English language. In the interviews they respectively stated that:

... it is hard to follow everything he says ... and to respond to his questions in the class is always hard ... but I am trying to make sure that I can speak and understand English well (Losi-CS₁S₁Int).

I try to listen very carefully to what he says ... words that I don't understand ... I write them down ... later I looked for their meanings in the dictionary (Simeona-CS₁S₂Int).

Losi also talked about his experience when working on activities such as classroom tasks and homework. He said that:

[The] activities really help to know what the lesson is about ... short questions and sometimes just calculations ... but there are times that I just cannot be bothered reading the notes because of the

language ... [and] ... so when it comes to preparation for a test or an exam ... [I] practise by going over the activities rather than reading the notes (Losi-CS₁S₁Int).

The notes written in English were made available to the students in handouts, in which the teaching followed through. Point-by-point, line-by-line, the teacher discussed the chemistry principles involved using English language:

Teacher called “altogether read bullet point 3.2” ... started talking about sources of naturally occurring hydrocarbons (Malaki-CS₁TCOFN₂).

For some of the student participants, they needed time to go through the notes to understand the English words in the notes. Some of these students were not quick readers especially in English and needed much more time than the teacher allowed to read and complete an assigned task. Student Janine in the interview stated that:

... some handouts are given during the class and he [teacher] starts talking about them, so I haven't had the time to read those new notes ... it is not enough because the language is hard and chemistry concepts are not easy to understand ... hard for me to respond or answer questions in class (Janine-CS₁S₃Int).

Despite the difficulties that the students revealed, Malaki was strongly of the opinion that if:

... we [teachers] encourage them to speak and respond in English, it will help them in their exam and beyond, ia ma lesi lea e fa'akana lava ele kakou makagaluega le kaumafai ia lelei le Igilisi (Malaki-CS₁TIInt). [Translation: And also our Ministry has put a lot of emphasis on improvement of English.]

The sole medium of instruction for the Samoa School Certificate (SSC) examination in Year 12 subjects is English. While the English language was considered important for students' examinations and the dominant language in the teaching of chemistry in CS1, the Samoan language was also used by Malaki for various reasons. These were: (i) to ask general classroom questions; (ii) to give directions; and (iii) often to discipline the students. These reasons are reflected in the following:

[Teacher] asked students (i) “E iai se fesili?” ... students answered “Leai”... [then says] (ii) “Se'i kago la e kope mai le kakou activity ga ei le handout pe afai ole ga” (Malaki-

CS₁TCOFN₁). [Translation: “Any question” ... “No” ... “Now can you quickly do the activity in the handout if that is the case”.]

In the second lesson Malaki:

... [*called out to the students*] (ii) “*lua miguke e kope ai le kakou mea ga*”
(*Malaki-CS₁TCOFN₂*) [Translation: “Two minutes to quickly do our work”.]

At one stage during the second lesson, the teacher got upset because he could not hear the students’ voices. This was because the grounds men were mowing the lawn near the classroom. Switching to the native Samoan language he called out in a harsh voice to the students:

(iii) “*lea e le’o mana lelei e oukou lo’u leo, laga lea e fua lo’u leo i le leo la e sau mai o, eke kankala mai e soli lou leo ele moa vao e le magaia!*” (*Malaki-CS₁TCOFN₂*) [Translation: I am speaking loudly to be heard above the lawnmower. If you speak quietly and the lawnmower drowns you out, we cannot hear you and that is not helpful!]

Apart from using Samoan language as detailed above, some of the students wanted it to be used in the discussion of the chemistry ideas. For example:

He [teacher] should use Samoan language because I understand it very well; it's my mother tongue ... I can easily understand ... discuss ideas with others in Samoan ... as oppose to when English is used (Losi-CS₁S₁Int).

It would be better if there was more mix of Samoan and English ... really helps me to pick up [understand] what [chemistry ideas] he [teacher] is trying to explain (Simeona-CS₁S₂Int).

I bring these ideas in Samoan to understand the notes [English] ... can explain things as long as I understand the topic well (Janine-CS₁S₃Int).

There are different viewpoints stated about the languages used in CS1. From the teacher’s viewpoint, the constant use of English language was primarily for students to become familiar with the language as it is the language used in the examination. It also served to enforce the emphasis by MESC for students to become better in the English language. However, the data revealed that there were difficulties in understanding both English as the

medium of instruction and also the chemistry concepts. Similar findings were reported by Johnstone and Selepeng (2001) in their study of Scottish schools where half of the students had English as their first language and the other half came from various other language backgrounds. They found that learning science through the medium of English poses problems for students whose mother tongue is not English.

Malaki realised the difficulties that students experienced with the use of English language so he continued to reinforce and encourage students to practise. The observations showed that the quality of students' English was associated with them being able to understand and attempt to answer the teachers' oral questions. However, this was not common in the three lessons where most of the students seemed to remain quiet when he asked questions and tried to get them to answer the questions.

Social constructivists believe that there are connections between language, culture of the people involved and cognition. In this regard development and learning involves a passage from social contexts to individual understanding and that language is seen as basic to developing and mediating thought (Vygotsky, 1978). However if the language use is unfamiliar the students are generally not so forthcoming with verbalising their ideas publicly in front of their class mates (Chin, 2007) and may experience difficulties in understanding chemistry concepts (Aguilar, et al., 2010; Asabere-Ameyaw & Ayelsoma, 2012; Gayle, 2000; Kim & Wai, 2007).

Moreover, educational outcomes are negatively affected if there is a difference between the languages which children speak at home and the language used in educational system (Hampden-Thomson & Johnston, 2006). Students who have a home language that is different from the language of instruction at school experience higher dropout rates (C. Benson, 2005; C. J. Benson, 2000; Klaus, 2003).

4.4 Copying notes from handouts

The teacher revealed that copying notes was a support, because there is a possibility that the students would read as they write. Some of the students also reported that the notes contain information necessary to help them pass the exam. Class notes were prepared in handouts by the teacher and were made available to the students at the beginning of the

lesson, with some appearing to be used for more than one lesson. The handouts contained information from different textbooks pasted together and photocopied. Every student in the class was instructed to copy the notes from the handout into their notebooks. Note copying was the most common activity in CS1. Malaki shared in the interview that:

[I use] all sorts of textbooks that [I] can find that explain the chemistry concepts as clear as possible for the students. Some notes [I] get from the NZ Pathfinder Series Year 12 ... not all because there are things that are not to be covered in this level ... but in Year 13 ... and yes ... I feel it's important if they copy these notes into their notebooks in case they lose a page because I get really upset if someone comes back and say I lost my handout ... (smile) ... so it's safer to record everything in the notebook (Malaki-CS₁TInt).

Another reason raised by Malaki which seemed to drive him to continue getting the students to copy the notes into their notebooks was that:

... as they write they remember the material, because I know for sure they don't read as much ... they will read then copy, so copying the notes into their notebooks is a guarantee that they had read the material; they had gone through word by word, and this is what I want them to do, go through all the notes ... [if] they still do not understand, then I look at some other ways to help them understand (Malaki-CS₁TInt).

The students, however, did not support Malaki's idea that they read and understood when they were copying the notes. They perceived note copying from handouts into the notebooks in various ways. For instance, in the interviews Losi, Simeona, and Janine respectively described that:

Sometimes I ... look forward to copying notes because this is when I ... do something in class ... copying notes is a guarantee that I have done something in class (Losi-CS₁S₁Int).

Spending my time in class to copy the notes does not help me learn chemistry, because I don't think about the notes while copying ... I can do it at home (Simeona-CS₁S₂Int).

Copying notes without an understanding of it is very difficult ... I rather spend more time on trying to make sense of the chemistry ideas than on copying the notes (Janine-CS₁S₃Int).

Sometimes during the classroom observations, Malaki explained the chemistry concepts and wrote extra notes or diagrams on the board. To the students, everything that the teacher says or writes on the board is seen as important, specifically for their preparations for the SSC examination at the end of the year. Understanding the chemistry ideas is another step which may come later, but at this stage the notes are at least recorded in their notebooks. When asked about the importance of having all the writings and sketches from the board, Losi and Ruth commented respectively:

It is important to have everything that the teacher is trying to explain, although I miss other things because my writing is slow. I believe that the teacher gives us the information that he [teacher] wants us to know for the exam (Losi-CS₁S₁Int).

Of course it is important to have all of them. The teacher told us that what we talk about in class and from our notes will be useful in the exam, so I have to pay attention to all of them, which is why I quickly copy them down in my small book when he [teacher] writes on the board (Ruth-CS₁S₂Int).

As the students shared their views about copying notes into their note books, they also talked about the format used in the presentation of the notes. It included the layout and length of the notes as well as the appearance of diagrams on the handouts. Here is what four student participants had to say when asked to comment about the chemistry notes:

I find it hard when we have the notes in paragraph. I don't like reading ... paragraphs, too long ... can't concentrate ... best to have them in points then I can easily understand it, some points I can memorise, like the one 'Like dissolves the like' (Losi-CS₁S₁Int).

hard to locate the examples because they were all distributed throughout the paragraphs, but if in points, would be a lot easier to identify and would definitely be easy to remember ... hard to remember or understand the whole passage (Simeona-CS₁S₂Int).

Just a few suggestions if possible, it will be nice if we could have coloured diagrams when showing some reactions, for example the notes say the indicator² changes colour when added in an alkene

² Qualitative test for unsaturation required in Year 12 is the use of red-brown bromine water: it decolourises in alkenes and alkynes only.

but NOT alkane, but the diagram is black and white. Having this match between the diagram and the text help me recall it, since we don't do the experiment (Janine-CS₁S₃Int).

the teacher gives us handouts full of notes ... I get tired easily when reading them ... perhaps in bullet points (Ruth-CS₁S₃Int).

While the above students shared the difficulties they experienced while trying to read and make sense of the notes, Malaki was more concerned about his role as a teacher to present the subject content with explanations and making sure that the handouts were available prior to discussion. When asked whether he realised that students found the notes difficult Malaki stated:

I am not sure ... students need to talk to me about that ... my role ... is to prepare the notes ... the notes help them understand more about what we talk about in class, they have to read it ... I often give more information about a chemistry concept ... just some different views or descriptions ... at least they [students] are exposed to these views ... when I see some talking to another while they are supposed to listen or do the work I get frustrated, because this means they do not listen to the instruction ... I ask them if they have any question they say no, yet they turn to one another and talk ... this means they talk about other stuff ... not chemistry ... so I stop them from talking ... unless I know it is a good reason to talk to one another then I let them (Malaki-CS₁TInt).

Although the teacher's intention is to provide all the notes and information necessary for the exam for students to copy into their notebooks, the students indicated that they had difficulties in learning them. Palmer (2009) confirmed in his study that in science tasks there was "low interest in the copying of notes" and students may not be able to learn the material presented to them in this way (p. 159). DiCarlo (2009) described such methods of teaching as providing teacher-centered experiences rather than dynamic student-centered experiences that engage students in learning. In this setting, the teacher assumes the responsibility for presenting a common body of knowledge to all students, and the students assume the responsibility of repeating it when answering questions in a task, or in the exam (St. George & Bourke, 2008). However, student responses suggest that often information is transferred from the teachers' notes to students' notebooks without going through the minds of the students themselves. The teacher perpetuates the process by attempting to transfer knowledge to students through lectures and note copying rather than through

active involvement and personal investment in the process (G. Lee & Lee, 2007). The students in CS1, however, had no other choice but to complete copying the notes into their notebooks as Malaki kept reminding them in every class.

4.5 Future careers in science/chemistry

The study revealed that the students chose to take chemistry because of future career that they had chosen. This was seen as a support in this case study because these future aspirations seem to motivate the students to learn science/chemistry at this level onwards.

In junior science levels (Years 9-11 in Samoa) basic scientific ideas are introduced for students to be familiar with before embarking on a full chemistry (or physics or biology) course in Year 12. Here students receive their first major exposure to chemistry in the classroom and laboratory. Generally, their Year 12 teacher seems to have an important influence on students' attitudes toward the subject and their aptitude for chemistry is put to its first real test as they begin to think seriously about the social and personal consequences of various career choices. In this study, Malaki kept reminding the students about their future options and the need to begin planning at this level. It was therefore important to seek out individual student participants' perceptions for choosing chemistry. Representative excerpts from their responses to the interview questions are listed in Table 4.1.

Table 4. 1: CS1 students' reasons for choosing Year 12 chemistry

<i>Student participants</i>	<i>Student participants responses</i>
Losi-CS ₁ S ₁ Int	I want to become a [medical] doctor
Simeona-CS ₁ S ₂ Int	I want to be a pharmacist
Janine-CS ₁ S ₃ Int	Now I want to be a [medical] doctor
Raylene-CS ₁ S ₄ Int	I want to understand some of the things that happen in our daily lives
Ruth-CS ₁ S ₅ Int	I want to become a [medical] doctor

In the classroom observations, Malaki reminded the students that it was worthwhile finishing Year 12 chemistry with high results as this determined the possibility of continuing chemistry onto the next level:

Aim high ... you [students] should all get grade 1³ in the chemistry exam ... think about what you need to do in the future ... you are doing chemistry or science now, what will be the next, in the foundation level, university and beyond (Malaki-CS₁TCOFN₁).

Study hard ... if you don't, you will not be able to pass School Certificate examination ... and score high marks in order to get grade 1 or 2 because this is what we all want, good grades, and definitely a place in the next level for you will be guaranteed ... so we are preparing you for that ... and the world out there ... we challenge you to do your best (Malaki-CS₁TCOFN₃).

The reasons suggested by the students for choosing specific future career varied. For example, Losi during the interview stated three reasons:

I've seen the (i) need in our hospitals and I hear many people say that [being a] doctor is good, (ii) good pay, and (iii) we [in Samoa] don't have many doctors ... so I want to become a [medical] doctor ... and therefore I will try my best this year to do well in chemistry ... to achieve my goal (Losi-CS₁S₁Int).

Experiences mentioned by some of the students in the study reflected the significance of family members as models to them. A study by Utumapu-McBride, Esera, Toia Tone-Schuster and So'oaemalelagi (2008) emphasised the importance of the roles of family on Samoan students' learning achievements in Samoa and Aotearoa New Zealand. In Samoa, family members are paramount in supporting educational success because of the *fa'a-Samoa* processes, which they engender. For instance, Ruth felt that becoming a doctor was her only option and more importantly to make her parents and family proud. When asked about her reasons for wanting to become a doctor, she indicated in the interview that:

I want to be a doctor in the future ... that is why I chose science ... I can do it ... my parents are very happy and willing to support me all the way. So I don't want to disappoint myself and my parents. And I am sure that the whole class knows that I deserve the best job (Ruth-CS₁S₅Int).

³ Grade 1 is the best: grading system (1-10) used in the Samoa School Certificate Examination results

Janine indicated in her interview that she had struggled a lot in her junior science classes. Switching her interest in subjects from science – in primary (Years 7-8) – to arts in junior levels (Years 9-10) – then to science in Year 11, showed that she was either trying to explore opportunities in other subjects or was not sure of what to do in senior secondary levels. However, the last change that she undertook was identified with a reason for the selection of chemistry in Year 12 and continuing onto higher levels. According to Janine:

I thought I would do arts [history, geography], but my family ... my uncle was a science person but he is kind of mental [mentally ill] now, so I thought of following his footsteps and continue his dream, do well in science in order to become a doctor. Also my mum talked to me and hoped for me to complete what my uncle dreamed for, to become a doctor, yeah, she really wants me to go for it and I agree, so she and my family are willing to support me so I am really working hard, although I admit that I didn't do well in the junior levels, but I am all for it now (Janine-CS₁S₃Int).

Simeona shared in the interview that:

I know this is the kind of job that relates to chemistry, and therefore I can use my knowledge of chemistry ... and because I like chemistry, I think I have to work harder to get my goal: pharmacist (Simeona-CS₁S₂Int).

Raylene on the other hand was interested in using chemistry knowledge to understand the fundamental processes, properties and the behaviour of things around us. She stated in the interview that:

Science was my favourite subject in primary schools. Then chemistry at junior levels, I was very good at it, I think because I had teachers who really gave us the opportunities to see the science in our everyday life. She was so good, I got to actually realise how science applies to us ... I remember we talked about evaporation of liquid water [to] form gaseous water [vapour]. I can still remember that when I cook at home, the water disappears from the pot and the steam forms, yeah so cool. So I always try to apply what we do in class to something out there. It really pushes me to continue learning chemistry, because now I know that chemistry is like a backbone, all these substances [in real-life] contain some kind of chemical that we study in chemistry (Raylene-CS₁S₄Int).

Although the students' future career aspirations may be long-term individual work related goals (VandenBos, 2007), they have clearly indicated in this study that these are the jobs

they wanted to achieve from doing science or chemistry. Educational psychologists emphasise that developing students' goals and motive involves a desire to learn because of future career aspirations (Pintrich, 2003). In other words, doing well in chemistry has utility value (Eccles & Wigfield, 2002) The importance of future career choice is consistent with both vocational and motivation research. For instance, vocational interests are conceptualised as patterns of likes, dislikes and indifferences regarding career-relevant activities and occupations (Lent, Brown, & Hackett, 1994). This is reflected in the findings that suggest that most of the student participants have chosen chemistry in order to become doctors. On the other hand, models of intrinsic motivation that focus on the phenomenal experience of interest conceptualise interest as a dynamic process characterised by high levels of tasks engagement, concentration, creativity and enjoyment (for example Pierce, Cameron, Banko, & So, 2003). This second model of intrinsic motivation fits well with the goal of science education; however, the findings showed that the student participants were affected mainly by extrinsic factors, such as jobs, money and family members.

Preparing students for their future roles in the world of work has become increasingly important for school counselors and educators generally. As a result of changes taking place in the workplace and the rapidly changing world, the challenge is to prepare students to enter and be competitive in a world-class workforce (Daggett, 2010). Challenges faced by the teachers as they prepare the students for future careers has being debated in the literature whether constructivist instruction is effective when compared with direct instruction (Kirschner, et al., 2006). Windschitl (2002) suggested that a teacher who hold a constructivist view of learning “use teaching strategies which involve challenges to, or development of, the initial ideas of the learners and ways of making new ideas accessible to them” (p. 140). Additionally, the successful development of knowledge constructions, however, depends on the teachers' effective guidance (an optimum level of instruction) to enable students to engage and develop conceptual understanding (Taber, 2011).

In Samoa, science (and technology) plays an important role for the country's development (Government of Samoa, 2007). Also science is a major engine enhancing the country's sustainable improvement (Ministry of Education Sports and Culture, 2006c). It permeates every aspect of modern life and full enculturation into today's technological society

necessitates the understanding of science (Rowlands, 2008). In addition given the level of competitiveness and the rate of change in the workplace, it is essential that students become as prepared as possible to enhance their chances of success. Furthermore, hopefully these students become contributors to the Samoan community just as they stated in the study, and have the opportunity to live satisfying productive lives.

4.6 Ole vā male faiaoga–respect the teacher

This key finding suggests that the Samoan culture was seen as a barrier by the teacher. This is because it is seen as one of the reasons as to why students do not ask questions to the teacher (adult). In fact, one of the most significant core values of the Samoan culture is the value of *vā* [a code of behaviour between people]. Samoans conduct their lives according to the unwritten principles of *vā* which in its simplest form means the maintenance of relationships between people, between *aiga* [families], between villages, between districts and finally between the people themselves and *Le Atua* [God] (Tui Atua, 2009). Thus, the structural features of Samoan societies such as rigid hierarchies of authority and strong community cohesion would be likely to engender patterns of learning that involve clear norms of respect for (knowledgeable) elders. In the classroom, respect is portrayed within the inter-relationships between students and their teachers. Malaki realised that most of the times students respected him, being their teacher. During the interview he said:

... Students are taught at home to respect by listening, without contesting their elders. This is what is happening in class they just sit and listen ... it is not good because they are here to learn, to question to gain understanding (Malaki-CS, TInt).

What is being demonstrated is an act of *fa'aaloalo* [respect] and what is being followed are Samoan cultural values. In this regard, students respect the (knowledgeable) teacher and therefore refrain from expressing their own opinions, even when that may contribute to the teaching-learning processes. For example, when asked in the interview:

Is this a good idea for you as a student to keep things hidden from your teacher, especially things that may have hindered your learning? (Researcher)

Simeona indicated that:

It's ... hard to tell the teacher what to do or how to do his teaching ... for me as a Samoan, I respect him [teacher] and everything he does I respect, I mean I will ask him to explain more

about a term or idea in chemistry but to tell him that his teaching is too fast or to slow down, is, I think is out of bounds but I can always check with my friend if something is bothering me ... I also realise that sometimes I can barely see what is on the board especially in rainy days ... sometimes it's hot and I feel so uncomfortable ... but I can't say those to him (Simeona-CS₁S₂Int).

The concept of respect was also mentioned in the interviews when the student participants talked about their work samples. For example part of one of Losi's work samples (Figure 4.1) was further explored during the interview. In his explanation:

I really don't know why it is ... wrong [referring to 1b in Figure 4.1] ... molecular formula is correct [$C_{12}H_{24}$] ... structural formula is also correct but I don't know why, I had a look at one of the student's books and it's correct, we have the same answer, that's how I know it's correct. But ... I don't want to go back to him and argue because that's rude and disrespectful in the fa'a-Samoa; I just have to make sure it's correct then yeah (Losi-CS₁S₁Int).

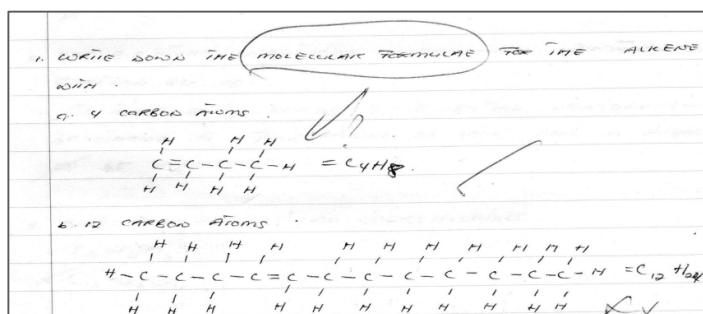


Figure 4. 1: A portion of work sample collected from Losi (Losi-CS₁S₁WS1)

Ruth shared her opinions about the notion of *vā* when she was talking during the interview about asking questions to the teacher.

As students we observe the vā, and this vā ... actually embraces our Samoan culture. It reminds us of our code of behaviour with other students and with the teacher especially, part of this includes fa'alogo ma usita'i (Ruth-CS₁S₅Int) [Listening and obedience].

Usita'i or obedience is another important core value of the Samoan culture and *vā*. The students in this study revealed that the cultural expectation is that they obey the teachers and never disagree. Such expectation makes it difficult for them to openly share their opinions or ask questions even if the teacher gives opportunities to ask. This is especially when there was a possibility of differing points of view (Y. C. Wellington, Ah Sue, Achica-

Talaeai, Sappa, & Sauni, 2006). Evidence showing the execution of *usita'i* by students in CS1 was reflected in: (i) task completion; (ii) task submission; and (iii) silence during class discussion. For instance, when students were instructed to work on a specific task and submit on time the student participants in the interviews confirmed that:

... when our teacher told us to do something he really meant it, and we had to obey it ... because if we don't do it ... he will be angry ... scold us sometimes (Janine-CS₁S₃Int).

Taua tele i lo'u olaga a'oga le usita'i ile faia'oga, e tatau lava ona usita'i i fa'atonuga uma e fai mai ai le faia'oga, auā o ota matua ia pe a ou o'o mai ile a'oga. Afai lā ... tate lē usita'ia fa'atonuga ia e fai mai ai le faia'oga, lona uiga tate le mauaina fo'i le poto la e naunau mai ai latou ina ia ota maua (Simeona-CS₁S₂Int). [Very important in my school life to obey the teacher, I must obey all instructions from the teacher, because they are my parents when I'm in school. If I don't obey the instructions from the teacher, it will be impossible to gain the knowledge that they desired for me to obtain.]

In support of the students' views about task completion and observing *usita'i* in class, findings from classroom observations indicate that some of their reactions and ways they behave in class relate to this concept. In the second classroom observation Malaki asked students, "*Malamalama?*" [Understand?] (CS₁TCOFN₂). Immediately there was a response from the class: "*Malamalama fa'afetai*" [Understand thank you]. The teacher looked at his watch and said:

"Quickly work on these examples [tasks], I give you three minutes to finish them, then we talk about it before the bell rings [for the next class], vave!" (Malaki-CS₁TCOFN₂) [Quick].

But when they were asked during the interview whether they really understood the teacher when he asked *malamalama*, here is what some of the student participants said:

Kele a o kaimi kake le o malamalama ai ... but I have to give an answer or else the teacher gets upset (Losi-CS₁S₁Int), [Most of the time I don't understand.]

Ga iai lava gai mea ga sa malamalama ai (Simeona-CS₁S₂Int). [There were some parts that I understood.]

Yeah I think I did ... sometimes not much ... but we still have to answer in case he gets mad at us (Janine-CS₁S₃Int).

When given a task to complete, the students wasted no time but focused on completing the task in the specified time. In Samoa, having the students follow instructions is considered important to the teaching and learning of any subjects. Malaki indicated that:

Our Samoan culture plays very important roles in education, for example we tell the students what to do and they do, and I know that they are told at home to usita'i, and if they do what we [teachers] tell them, they will be successful for sure (Malaki-CS₁TInt).

Time and date for submission of tasks for assessment also indicated some degree of *usita'i*. According to the teacher:

We [teacher and students] have assigned a time to submit [tasks] for marking, and everyone knows it, if we have an overnight task, they know it is to come back the next morning, they [students] must hand in their books when they come ... in the morning (Malaki-CS₁TInt).

When asked in the interviews about how they perceived this idea of tasks submission, some of the student participants stated:

Of course this is my part of the learning process, I have to abide by the instructions that my teacher gives. It is important for me, to complete the task and submit on time so that the teacher can do his part ... I also don't like when he gets angry and start scolding us ... so I have to make sure the work is done correctly and to be submitted on time ... if not ... we will be in trouble (Ruth-CS₁S₅Int).

Similarly, Raylene, during the interview, stressed the important roles and responsibilities of every student in order to become successful:

We are here to learn, our role is to listen and do what we are asked to do, and this includes completing and submitting the tasks on time ... important to do our part (Raylene-CS₁S₄Int).

Direct instruction from the teacher, particularly on how to answer questions orally or in writing was apparent and students were expected to follow these instructions. For example the field notes from the second classroom observation recorded the:

Teacher asked a question ... "What do we need to get out of this experiment?" [The experiment was presented orally] Looked around ... no-one responded. Teacher said "se kaukala mai, amai a ga 'ole kali, sau sa'o a ile mea maga'o ai le fesili, leai se mea e ala ai fua ga faigakā. Faiga fo'i ga ole su'ega, sau sa'o a le kali, fa'apu'upu'u ma fa'afaigofie (Malaki-CS,TCOFN₂). [Talk to me, give the answer only, straight to the question, not hard. That should be the way to go for the exam also, straight to the answer, short and simple]

As students practised by writing short and simple answers to questions in tasks (or in past years exam papers), they tended to memorise short summaries of chemistry concepts.

During the interview Raylene commented about the way the teacher encouraged them to answer questions. She said:

I like it. It enables me to remember the materials, because too long is hard to remember but short versions help me to memorise the important stuff (Raylene-CS₁S₄Int).

Further comments about the way the teacher encouraged students to answer questions in class as well as in exams were revealed by Janine in the interview. She said that:

Adopting this style of answering saves time, especially when we come to exams, we don't have much time to think and to write down long answers, so keeping answers short really helps, and the good thing is that our teacher told us to do it this way, so who else do we listen to but the teacher. He marks our work, and if we don't do it, this means we are not obeying, and therefore we probably lose marks and he will come back to us and tell us off for not listening (Janine-CS₁S₃Int).

It was also stated by one of the student participants that he had to think of ways to address his concerns, when his ideas differed from the teacher or when he was unclear. In the interviews, Simeona stated:

To me, it is important to ask the question in a way that is appropriate in our fa'a-Samoa, like if I ask something like ... why are ... structures that you drew on the board showed straight branches and the notes you gave and other textbooks ... like bending structures? An appropriate way to present this perhaps, would be, please Mister, what is the difference between straight [in your diagrams] and the bend structures in the handouts? Like that. So I have to think of these ways before asking a question (Simeona-CS₁S₂Int).

When asked for reasons behind his viewpoints Simeona continued:

We also have to be mindful of what we say, and the way we say it, its tū ma aga fa'a-Samoa [conduct and behaviour in the Samoan way], when we speak we speak politely in a way that does not offend others ... When someone says something that sounds ill-mannered, the whole class looks at you (Simeona-CS₁S₂Int).

The findings related to the concept of *vā* from the student participants show that there is an influence of the *fa'a-Samoa* to the ways they participate in the chemistry classroom. The student participants believed that disobeying the teacher's instructions involved disobeying not only the school rules but also dishonouring their cultural core values. Moreover, the act of being polite was considered important when answering the teacher's questions in class or participating in the learning tasks. The students believed that their role as learners involved listening, obeying and doing things in the ways the teacher wanted, such as writing answers to problems in tasks or in questions in the SSC exam.

4.7 Chapter summary

This chapter has provided the results and discussions of the four key findings from CS1. The first revealed two opposing views from the teacher and students around the languages that were used in the chemistry classroom. The teacher stressed the importance of constant use of the English language to help students be able to answer examination questions. In this regard, English language was viewed by the teacher as a support for students' achievements in chemistry. However, students identified some difficulties in reading, writing, expressing and understanding chemistry concepts because of the English language and therefore suggested the Samoan language to be used as well. As such, the findings from the students suggest that the use of English language to teach chemistry in CS1 was a barrier. If the language use is unfamiliar or different from their home language, the students were generally not so forthcoming with verbalising their ideas in front of their class mates and may have experienced difficulties in understanding the abstract nature of chemistry as well as its own (scientific) language (C. Benson, 2005; Chin, 2007; Hovens, 2002; Lewis & Lockheed, 2006; Smits, et al., 2009).

The second key finding was about copying notes from handouts. Malaki's practice of copying notes as a guarantee for student to read it all, to remember and come to some

understanding of it did not seem to work as intended. Instead, some of the students chose to copy the notes in their free time and to concentrate on doing the tasks in class. When given no task to do or when trying to avoid being selected to answer questions, some of the students in CS1 revealed that copying notes became a necessity. Despite the difference between teacher and student views about the value of copying notes, the students were left with no other choice but to copy the notes as they were instructed to by the teacher.

The third key finding highlighted the students' future careers in science/chemistry. In particular, the student participants chose to take Year 12 chemistry because of career aspirations. Three student participants wanted to become medical doctors; one as a pharmacist and one wanted to know how things work in everyday life. As the teacher stressed the importance of high achievement in the SSC chemistry examination, the students realised that this was the way to help them achieve their career choices, and thus encouraged themselves to work hard. As the students tried to cope with understanding the medium of instruction as well as the chemistry concepts in order to get high marks and working towards achieving their goals, they were presented with huge amount of content to learn and regurgitate for the exam.

The fourth key finding is the central importance of *fa'a-Samoa*. Students related everything they do in the chemistry classroom to the accepted ways of doing things in Samoa. Whether they were told to perform in such ways at school or not, these students were expected to perform in a way that ensured cultural protocols were observed and these acted as guides to how they participated in the chemistry classroom. The student participants observed the *va* and showed respect by being submissive through listening and following the teachers' instructions in the classroom. They realised that the teacher was giving directions and techniques which were helpful in writing answers to the questions in the tasks or the exam.

The next chapter presents a detailed account of Case Study 2 (CS2) and the key findings developed from the data collected are discussed in light of the literature.

Chapter 5 Case Study 2 Results

5.1 Introduction

This chapter reports and discusses the findings from Case Study 2 (CS2). It begins with a brief description of the case—such as the classroom facilities, duration of chemistry lessons as well as the changes to the school programme. Following this, the results from CS2 are presented in terms of four key findings, which concern:

- Lecturing: A way to deliver exam related facts to students.
- Examination pressure and maintaining school's standard
- Lack of student engagement
- *Aua le pisa!* (Stop the noise!)—what does it mean to the teacher and the student?

Evidence is presented to support each finding and includes a discussion to determine whether the findings agree or disagree with the body of existing literature. Direct Samoan quotes from the participants are used throughout the chapter to avoid mistranslation of their responses. Translations are provided after each comment.

5.2 Description of Case Study 2 (CS2)

CS2 was a Year 12 chemistry classroom in School 2 (S2), another urban secondary school in Upolu. It was one of two Year 12 chemistry classes offered at the school to accommodate the large number of students enrolled in chemistry. All chemistry classes were held in the laboratory room, which appeared to be too small for the number of students in the class. There were long laboratory benches which stretched from one side of the room to the other, leaving spaces at both sides for students to walk through. There were not enough stools available for the number of students and therefore some of them used chairs which were too low for the benches. Unlike CS1 the notes for every class in CS2 were written on newsprint and were often pinned on the board before the students arrived.

Each chemistry class was scheduled for 50 minutes, except for occasions when the school administration decided to change the schedule to have time for cultural practice or sports activities that occurred at the time of the research. The researcher was not informed about

the changes prior to turning up to the research school site. Further arrangements were carried out to fit with the school changes of programme.

The four key findings are presented in the next sections with support from the data and are discussed in relation to the literature.

5.3 Lecturing to deliver exam related facts to students

The findings from classroom observations in this case study revealed that the teacher Eileen was constantly lecturing. Lecturing was considered a support by the teacher as she confirmed in the interviews that this was the way that she thought would help her to get the exam related facts to students. The students however showed different perspectives to the use of lecturing as a teaching style. The students revealed that such method of teaching was boring and they could not engage with all that she was presenting in the lessons.

During the first classroom observation:

... the teacher was standing at the front of the classroom, looking at the door as students entered one by one ... bell had already rung for the start of the lesson ... teacher called out to control the noise from those students already in the room so that the lesson could make a start. Eileen started the lesson by introducing the topic. Today we are going to talk about functional groups. Does anybody know what functional groups are? What are they? Where can we find them? What do they do? (Eileen-CS₂TCOFN₁)

While waiting for an answer, the student participants were seen doing different things such as:

Florence was looking into her school bag and took out a textbook (Florence-CS₂S₃COFN₁).

Joyce was talking to the student on the left side (Joyce-CS₂S₄COFN₁).

Valeni was staring in the teacher's direction (Valeni-CS₂S₂COFN₁).

May was staring at her note book (May-CS₂S₅COFN₁).

Sam was talking to the student on his right side (Sam-CS₂S₁COFN₁).

It appeared that Eileen was trying to have a discussion but students did not want to take part. When no response came from the class, Eileen switched into lecturing mode and gave up trying to elicit student responses. In this regard, Eileen spent most of the class time presenting information including: (i) the chemistry concept: functional groups, (ii) a definition of specific groups: atoms in molecules that are responsible for the characteristic chemical reaction of the molecules, (iii) an illustration: a structural diagram of a molecule on the board and (iv) examples of the concept: circling and naming the functional group. While the teacher presented information about functional groups, she kept on mentioning ideas from past lessons in an attempt to compare and contrast ideas.

When Eileen was asked in the interview about the teaching methods that she used she replied:

... [it was] more of lecturing I think, yeah, [I] did quite a lot of lecturing throughout the lesson ... reasons ... there are 31 students in the class, too many, so the lecture method is more suitable for such a big number. Another interesting point is that I did not learn ... this method, it just came naturally. In my experience as a student ... my teachers used [it] ... we learnt a lot ...and most of us went to National University of Samoa – NUS (Eileen-CS₂TInt).

Do you think that you achieved your objectives when you use this particular method? And do you think the students were able to learn what you intended for them to learn? (Researcher)

Oh yes, I know ... at the start of my teaching career, I was struggling to find the right method to use; now I think this is the best for my students and myself ... I know that my objectives have been met in all of the lessons, and I am confident that the students learnt the material. The most important thing for me as a teacher is to have something for them, give them the material for the exam ... that is why I have to prepare the notes on the newsprint ... we don't have textbooks suitable for our prescription ... so I have to find something ... use old textbooks that I have used and collected during my university years ... and lecturing is appropriate, especially we have so much to cover before the examination. And also, I don't want the students to complain that their parents paid fees to be taught, yet I give less (Eileen-CS₂TInt).

When you said it's the best for the students, what do you mean by that? (Researcher)

I feel that the students want the material that is relevant for the examination. For me, this is good, because I can give all that is relevant for their exam preparations. The prescription is so much to cover, so by delivering in this method, at least all the stuff is presented to them before the exam ... give them exactly what is required in the examination (Eileen-CS₂TInt).

Eileen asserted that the way she taught chemistry was necessary not only to present information to the students for the exam, but also to teach large class numbers. The data revealed that she continued presenting several chemistry concepts in one session. She confirmed in the interview that:

In Samoa, it is very hard to make students to speak out, if given the opportunity to talk or ask questions, they never take it. I believe that they come to school with expectations that the teacher gives them everything ... I try to make sure they have understood ... I ask them ... if they are then we move on ... to save time it is best to teach them with what the examination requires (Eileen-CS₂TInt).

The findings of this study reveal that while the teacher was constantly lecturing, instead of paying attention to her, some of the students were writing things in their notebooks and talking quietly with one another especially, when she was not looking. Some also seemed to draw attention to things that occurred outside of the classroom such as students from other classes roaming around the field. During the first classroom observation May was:

... writing something in her notebook ... copying the notes from the newsprint pinned up on the board (May-CS₂S₅COFN₁).

In the interview, May talked about the reasons as to why she chose to write instead of sit and listen to the teacher:

I know that I am supposed to pay attention to her [teacher], but I also feel that it is important to have the notes in my notebook, because if I don't have the notes, then the whole lesson is a waste of time. I feel that listening to her; I get mixed up and get confused easily ... because she talks about many different chemistry concepts in one lesson (May-CS₂S₅Int).

In the same lesson, noise constantly emerged from the right side of the classroom, where Sam and other male students were seated. Sam was:

... whispering [something] to another student [male] on his right side, then started laughing ... kept on looking outside (Sam-CS₂S₁COFN₁).

When asked to explain the reasons for making noise in the first lesson, Sam stated in the interview that:

I think I lost interest of what was going on in the lesson, I just couldn't focus, the whole time she talked was a bit boring to be honest, and she kept on repeating some other stuff that we already did, yeah, and talked for so long. I just couldn't stay focused for too long. It felt better when talking to my friend, had a bit of laugh, and then went back to listening to the lesson ... sometimes I try to explain something to my friend when he ask me for help ... he was not sure of one thing (Sam-CS₂S₁Int).

What do you mean by 'the whole time she talked was a bit boring'? (Researcher)

The stuff that she talked about was okay, it's the ... I think it was the way she did it. Some of the lessons I wished she could just give us an exercise [task], but every time she preferred to talk and therefore something simple to understand became more complicated, maybe because I lost interest in it that prevented my brain to actually absorb what she tried to teach ... sometimes I feel that I am not very good with remembering these stuff ... I am more of hands-on ... that is why I am thinking of becoming a mechanic ... relates to physics ... and I get to do things ... (Sam-CS₂S₁Int).

When asked in the interview about the reasons for looking at her note book while the teacher was talking about the lesson Joyce stated that:

I was looking through my notes. The teacher was talking; listening for too long is not my thing, so that day I was looking at my notes [from previous lessons]. I know that she is trying to give us everything to prepare us for the exam ... but the way she does it is boring (Joyce-CS₂S₄Int).

Valeni fell asleep in two lessons. When it was mentioned to him during the interview, he smiled and started telling his side of the story. He said:

I felt tired ... sometimes because I studied late at night, not enough sleep. So, I fell asleep ... sometimes it is hot and stuffy in the room ... makes me sleepy as well (Valeni-CS₂S₂Int).

So do you fall asleep in every chemistry class? What about other subjects? (Researcher)

No, other classes like our Maths, bio ... I never feel sleepy, we do lots of work and exercises [tasks] in or out of the room, but it [sleepy feeling] seems to come only when I have my chemistry class. I like chemistry and the teacher is good, nice lady, but yeah. I normally come in [chemistry class] not feeling sleepy; the lesson begins okay until some times later [in the lesson]. But if we do something else in class, I feel okay (Valeni-CS₂S₂Int).

What is something else to do in class that you refer to? (Researcher)

You know, things like some experiments, or something that makes me move around, get my brain active, not to sit down for too long; or talk to other students about chemistry, apart from sitting and listening to the teacher, ia pei ā ole pa'u ole vai ile kua ole pako le mea e kupu; cannot really learn anything at that time (Valeni-CS₂S₂Int). [What happens is more like water off a duck's back.]

The use of lecturing as a method for teaching chemistry in CS2 focused specifically on transmitting information. The literature describes that acquiring knowledge through transmission method involves storing information (that is dispensed by the teacher) in memory (Richard E. Mayer, 2002; Sfard, 1998). Retention of this information is measured by achievement tests. In Samoa, achievement tests may refer to the SSC exam or tests that are often implemented by the teachers. In this class Eileen controlled the topic, aim, content and organisation of the lesson. Emphasis was placed where the teacher wanted it. However, it was difficult for the students to maintain interest and attention for a full chemistry lesson. Rather, they were occupied with activities within their semi-private and private contexts (Nuthall, 2012) which may or may not include learning about the lesson and often did not include responding to what the teacher expected of them—to listen and answer her questions during the lesson presentation.

A great deal of evidence in the literature shows that lecturing is a relatively ineffective pedagogical tool for promoting conceptual understanding (for example: Knight & Wood, 2005; Schwerdt & Wuppermann, 2011). Some of this evidence shows that learners at all levels gain meaningful understanding of concepts primarily through hands on active

engagement with application of new information not passive listening to verbal presentation of science concepts (National Research Council, 2007; Schwerdt & Wuppermann, 2011). The student participants suggested that active engagement promotes interest in the lesson, avoids distractions and stops them feeling sleepy in class.

5.4 Examination pressure and maintaining school's standards

The data showed that there were institutional factors that influenced the way chemistry was taught in CS2. Some of these factors lead to support or barriers to chemistry learning. These included the pressure of a high stakes examination upon the teaching and learning of chemistry and the pressure to maintain or improve the status of science achievements in terms of the school's exam results.

The teacher saw her role in the three chemistry lessons as one of helping students to pass the examination. The teacher gave factual information to help them with their examination. In the classroom observations, Eileen was recorded saying:

... make sure you [students] know this stuff, it appeared in the past two years' examination, in case it appears again ... all you [students] need to do in the examination is to identify the functional group and circle it, read the instructions carefully and see what the question is asking for (Eileen-CS₂TCOFN₁).

I am here to help you [students] pass your examination, if you are not sure of anything, let me know, don't just sit there and stare at me ... I am expecting everyone to pass our test next week, it's an easy one, and we covered everything in our classes, so come prepared (Eileen-CS₂TCOFN₂).

I give you the exercise to help you practise for the examination; those are the types of questions that come in the examination, and why did some of you did not complete it on time? That is not good (Eileen- CS₂TCOFN₃).

The information presented to the students was intended to be tested. The questions are used in the learning tasks or homework for students to practise. One of Florence's work samples was the notes that everyone was supposed to copy from the newsprint (Figure 5.1).

Hydrocarbons. The simplest organic compounds contain only hydrogen atoms and carbon atoms and are called hydrocarbons.

Alkanes contain only C-C single bonds. They are said to be saturated, as no more hydrogen atoms can be added to them.

Alkenes have one or more C=C double covalent bonds. They are said to be unsaturated as hydrogen atoms can be added to them.

Alkynes have one or more C≡C triple covalent bonds and are unsaturated.

Figure 5. 1: A portion of work sample collected from Florence (Florence-CS2S3WS1)

In an examination-type question, students were supposed to remember from the notes (Figure 5.1) the facts about alkene molecules, to help them answer the question. For example, alkene molecules have one or more C = C, where = represents double bonds (underlined in Figure 5.1). In Figure 5.2, Valeni was given a handout to complete the questions, which appeared to be taken from an examination.

QUESTION 33 (33 Marks)

A. Hydrocarbons

Answer questions (i) to (iv) using the KEY LIST below. Not all items will be used and some may be used more than once. **Write the letter only.**

KEY LIST

(A) CH ₃ CH=O	(B) CH ₃ OCH ₃	(C) CH ₃ CH ₂ OH
(D) HCOOH	(E) H ₂ C=CH ₂	(F) CH ₃ COOH

(i) Select the alkene from the list above.

E (1 mark)

Figure 5. 2: A portion of work sample collected from Valeni (Valeni-CS2S2WS2).

Eileen talked with great confidence about her students and that they were going to do well in the SSC examination. In the interview she stated that:

I strongly believe that these students [whole Year 12 class] will pass the examination at the end of the year. That is my goal and my purpose for being here, is to teach them to pass the examination with high marks. If they don't, people – the principal, head of the science depart, or parents and

teachers' association and especially the parents, might ask me what I had done throughout the whole year. And I don't want to be in such position. So I train them [students], give them stuff in order to achieve that ... my responsibility is to ensure that they pass the examination (Eileen-CS₂TInt).

Why must they pass this examination? (Researcher)

It's a competition you see! Every student competes to get the best marks, I feel the same also and I want them [students] to get the best marks in chemistry (Eileen-CS₂TInt).

Eileen knew that the students would be asked in the examination to recall information. Thus, she attempted to ensure that the students knew how to answer the types of questions that would be asked in order to successfully pass the examination. This was very important to Eileen as her teaching performance may eventually be measured by the community through the students' exam results. Where the results are low, the community would question and perhaps criticise her teaching capability. She was very much aware that such external factors as examination results were the true expectations of the Samoan parents. They wanted their children to score high marks in chemistry as well as all other subjects.

While Eileen tried to make sure that students pass the SSC examination, she also talked about making sure that the students achieved higher marks compared to their achievement results in 2009, which were outstanding. Eileen believed that:

I need to ensure that there is an improvement in their [students] results, most of the students [whole class] came into Year 12 with marks over 80 ... I push myself to prepare well, before the lessons. I feel that these students expect a lot from me (Eileen-CS₂TInt).

What do you do, since you feel that the students expect a lot from you? (Researcher)

For my lessons, I make sure that they are planned out, what to say and [also what to] write on the board during discussion. I also choose the notes to give them [students]. I do not want to give them anything that may cause confusion. So everything, the notes is prepared before the class ... the time ... on the discussion ... sometimes I get frustrated if anyone makes noise or asks ... about a lesson

that we had done already ... they will use up the time that I had planned for the ... lesson (Eileen-CS₂TInt).

What if a student asks about something that you are talking about? (Researcher)

It depends, if I think it's a small issue, then I will quickly answer the question, but most of the time I leave the questioning part to do when I finish my part, then I give them [students] the opportunity. I also tell them many times, if you [students] have a question, you can write it down on a piece of paper ... ask me at the end of the lesson (Eileen-CS₂TInt).

Another factor that appeared to influence the way this teacher taught chemistry included the influences of those who were involved in the teaching of chemistry in the school in the past years. Eileen admired the work of the foreign chemistry teachers who had spent years of teaching science subjects at the school. She then expressed the pressure that she was experiencing in terms of sustaining the status of the school, particularly the results in chemistry and other science subjects. When asked to elaborate, Eileen indicated that:

Science teachers in the past did a magnificent job to promote science in our school, from our records, high achievers were science students. And I am sure the present students know about it, parents realise it also, thus they [students] want to be recognised like those students in the past. But you know what, this puts a lot of pressure on us [science teachers], trying to maintain this standard, the principal keeps reminding us [science teachers] about the previous experiences, more like challenging us to either maintain or become better. So when we get poor results in our unit tests, we feel that we have failed, so we got to put more effort into it and push harder, like I am offering extra tutorial sessions on Saturday, to help them (Eileen-CS₂TInt).

The data shows that such a reputation for the school was recognised by the community. For instance, Valeni in the interview stated that:

My father selected chemistry ... and said that our school is recognised to produce the top results in chemistry and other science subjects and always have the best chemistry teachers that can help me get the best results, and I believed my father because he attended this school ... many years ago ... he also talked to me of my future and I am aiming to be a doctor ... to help my family and my village (Valeni- CS₂S₂Int).

Eileen continued by describing the effects and the pressure that she and other science teachers were currently experiencing because of the past experiences and the status of chemistry.

... we [science teachers] have two chemistry classes, more than 30 students in each. There are more students to teach, but with limited resources, we have to seek assistance from other schools when it comes to experiments ... but with limited time I have ... I often leave experiments till later in the year ... hopefully the HOD and principal will have the stuff for me by then ... if not then we just have to talk about them ... we teach to make sure that most of these students if not all get high marks at the end of the year ... I am new to teaching, but I am actually under so much pressure to ensure [that] I meet or match ... the achievements of the students in the past years (Eileen-CS₂TInt).

How does this pressure affect your teaching and students' learning? (Researcher)

I make sure that time is not wasted in class, once they are inside, I quickly start the lesson, this gives me enough time to teach the lesson and explain the chemistry concepts. In this way, I can at least give everything that will help them in the examination. In every lesson I try to revisit and repeat important concepts and their meanings and functions ... as a reminder to them. For them, I think they are learning the material, but some of them need to be a little bit faster; there is a lot to learn in one lesson (Eileen-CS₂TInt).

Through this section of the investigation, evidence shows that Eileen's beliefs and personal experiences influence the way she perceives the teaching of chemistry. These personal experiences may act as 'filters' through which information about students, learning, and instructional strategies flow (Hollingsworth, 1989). Furthermore Pajares (1992) found that this filtering can lead teachers to redefine, distort, or interpret information in different ways. As revealed earlier, these experiences and beliefs became the centre of attention and acted as guiding principles to the way Eileen taught chemistry.

The Ministry of Education, Sports and Culture stresses the significance of achieving high results in national examinations but they also put a lot of emphasis on promoting deep understanding and meaningful learning (Meyers, et al., 2012; Ministry of Education Sports and Culture, 2004). Yet, existing classroom teaching and the current school curriculum is

packed with so much content to teach (DiCarlo, 2009; Lujan & DiCarlo, 2006; J. Osborne & Collins, 2001), that the latter becomes difficult. As well, the pressure of the national examination affected both the teacher and students in this study. Teaching of chemistry as facts became the dominant approach and students became passive recipients who tended to engage with surface learning approaches. In the surface learning approach, the intention is just to cope with the task and store information for the purpose of reproducing it later, with an emphasis on routine memorisation (Entwistle, 2000; Teaiwa, 2011). Such an approach gives the learners little time to think and acquire a deep understanding of the subject or to develop life-long skills (DiCarlo, 2009; Lujan & DiCarlo, 2006; J. Osborne & Collins, 2001). Deep learning and understanding of scientific concepts however is supported by constructivist's views that includes active learning processes involving relating ideas to daily life and looking for patterns and principles (Entwistle, 2000, 2003).

5.5 Lack of student engagement

Lack of student engagement was identified as a barrier where students could not engage with the lesson presentations. As the teacher put a lot of emphasis into the lesson (presenting, demonstrating and explaining the chemistry concepts appropriate to pass the examination), the students revealed in the interviews that they constantly forgot things that the teacher asked them to learn and remember during the lesson. Four students indicated during the interviews that:

... her [teacher] teaching seems okay, I listen to her at times, but if we revisit the same ideas a day later, I cannot seem to recall what I heard in class (Florence CS₂S₃Int).

I could not remember everything that she was talking about in class (Sam-CS₂S₁Int).

... if the teachers asks question in class about something that she just described I am able to answer correctly, but when I do an activity at home or the next day, I struggle a lot to remember the day's lesson and other previous lessons (Joyce-CS₂S₄Int).

No matter how hard I concentrate or how many times I read my notes, I find it very difficult to understand, despite the fact that the teacher had already gone through the same stuff in class ... I forget them all ... more like entering through one ear and exiting through the other (May-CS₂S₅Int).

In considering the ways chemistry was taught and the fact that students kept forgetting the ideas presented in class, it appears that there was a lack of interconnectedness between what the teacher intended for students to learn, how to teach it and the students' experience. The fundamental idea underlying the conception of engagement is that students must be meaningfully engaged in learning activities through interaction with others and worthwhile tasks (Palmer, 2009). Student engagement is the driving force for learning that precedes academic outcomes, and when students become disengaged from a subject, they forget ideas and eventually their academic performance begins to suffer (OECD, 2004). To become engaged in the lesson, some of the students shared in the interviews that:

I wish there was an opportunity for us [students] to talk rather than listen the whole time. I mean a time during our chemistry lesson where we [students] talk with our friends or class-mates about chemistry stuff, like we tell each other things, chemistry things, and then we get to hear and share with others while the teacher helps us to ensure we are on the right track. This I think, in my own opinion, once we are involved by doing, thinking, listening, and talking about all these chemistry stuff; this will be of great help in remembering what we do in class, and at the same time we learn something (Florence-CS₂S₃Int).

When Sam was asked about the reasons for not remembering he changed his facial expression. Initially he was smiling when telling how bad he did in the test, then he had a sudden serious facial appearance and said:

To me if it [lesson] is not interesting ... I just simply cannot learn the stuff that she tells us ... sitting here and listen to her is boring ... I want to do something ... so I turn to my friend (Sam-CS₂S₁Int).

Joyce gave several reasons for not remembering, all of which relate to disengagement. She said:

Education actively involves everyone, the teachers, students and parents. But, I feel that the teachers are the only one that [are] actively involved, few times our parents come into the circle ... like they pushed us to do our school work ... and tell us to try our best in school, but in class we are not at all involved, I mean actively involved ... when she ask us whether we understood ... I always say yes ... but doing an activity I can't remember anything at all ... and I know that the teacher sets these

task to find out about how much we know ... I like it they need to know and do something ... I also want her to know that I want to become a doctor in the future ... where we can apply our scientific knowledge (Joyce-CS₂S₄Int).

As Joyce continued to share her opinions, she made some interesting comments that reflected the relevance and worth of chemistry:

... we [students] should be encouraged to think positively about learning chemistry, like how does this subject make me a better person ... its place in my life, my family and the community ... if we do it this way, then I believe we will always remember the things that we study in the classroom ... I feel that we are forced to learn all this stuff, but I cannot really see what for, except for examination (Joyce-CS₂S₄Int).

In responding to what May said earlier, she was also asked to elaborate and to provide reasons for what she said about “entering through one ear and exiting through the other”. She indicated that:

... most of the things that she [teacher] said I can hear, but that's it, I don't really know much about them and so they just disappear gradually. I don't feel like I am part of the class at all ... but I need to learn all these chemical stuff, names and concentrations ... because I was thinking of working in a laboratory where they make all these medicines ... in hospitals (May-CS₂S₃Int).

Valeni gave some recommendations as to how to engage students in the teaching and learning processes. He suggested:

I think we need to change our focus, we are too much on the examination and stuff, but whether we are learning or not should be more important. Because if we change our focus in the classroom, it will allow the teacher to open up more opportunities for students to choose how they want to learn, and what they can do in order to learn it. At the moment, the teacher is guided by the fact that every student is to know the stuff because they will be asked in the examination (Valeni-CS₂S₂Int).

Other reasons why students forget the material related to the notion of hands-on experiences which is at the heart of science learning (Nersessian, 1991). All five students were asked the same question:

If you are asked by the chemistry teacher or the principal to recommend ways that you would want to see happen in class to help you learn chemistry, what would you say? (Researcher)

Labs, we need to do experiments, we need to actually see the things that the teacher gives us, list of things, but never heard of or seen before. Also it will be nice to see the reactions that she tries to explain in words and diagrams (Sam-CS₂S₁Int).

I think it is important to do some actions ... get to do, see, touch and investigate how these things work like in chemical reactions, rather than telling us everything. I know that we have limited resources, but perhaps some fun activities that we can actively participate (Valeni-CS₂S₂Int).

I am quite happy with our teacher, but maybe have time to do some lab experiments, and allow us to actually perform the experiment, perhaps she demonstrates first then we go ahead and do it ...with no lab experiment to do, I may lose interest in science ... a job ... am not so sure (Florence-CS₂S₃Int).

There are a lot of things that I know we should be doing activities apart from sitting and listening to her. This is chemistry, where actions should occur, not listening to the teacher like we are in a church (Joyce-CS₂S₄Int).

Lessen the talking time to have some time for activities, not copying notes or answering questions type. Some other activities that we get to work and experience new things as we work ... experiments, field work or field trips to local industries (May-CS₂S₅Int).

Laboratory and field experiences make science come alive (Clough, 2002), which is something that the students in CS2 wished to be incorporated into their class lessons. Indeed, “for more than a century laboratory experiences have been purported to promote central science education goals, including: the enhancement of students’ understanding of concepts in science and its applications; scientific practical skills and problem-solving abilities; scientific habits of mind; understanding of how science and scientists work; and interest and motivation” (Lunetta, et al., 2007, p. 395). Interaction surrounding lab and hands-on activities may also lead to more engagement than lectures because students’ can contribute ideas and participate in observation and exploration of scientific phenomenon.

However, the data showed that the teacher focused more on presenting information in order for students to do well in the SSC exam.

Although the students were given everything to pass the examination, students were struggling to remember because there was a lack of understanding, engagement and connectedness with the teaching strategy used and the materials presented. The students' viewpoint suggested the need for the implementation of experiences that involves both hands and minds, where they become actively involved in doing practical work or classroom tasks, rather than just sitting and listening.

5.6 Aua le pisa! (Stop the noise!)—what does it mean to the teacher and the student?

The teacher revealed that calling *aua le pisa* is a support to ensure silence in the classroom as she delivered the information and for every student to hear it. However, the students perceived this as a barrier as some of them were asking their peers for clarification of some chemistry ideas. *Aua le pisa* was one of Eileen's most commonly used instructions in the classroom, both during lesson presentation and while students were working on tasks. She said it softly the first few times when students begin to talk but, later, she raised her tone and she was very upset. Disruptions occurred several times during the lessons as Eileen attempted to control the noise made by some of the students. Students talked during the lesson for many reasons that Eileen was often unaware of. Instead of finding out why some students talked to each other and made noise, she quickly called to stop the noise (*aua le pisa*) and then continued the lesson. During the interview, Eileen confirmed that:

There are students, the same students every day; they drive me crazy. They tend to talk to each other, making so much noise while I am trying to explain something ... so rude ... they are taught at home to respect, which is when one talks, you must listen until you're given the chance to talk. I really don't know why they are like this ... and you know they talk about stuff not related to the topic ... wasting my time and other students (Eileen-CS₂TInt).

In general, different kinds of noises were observed from the students – students laughing; students talking, books flipping, furniture moving, sandals flapping and much more. Eileen seemed particularly concerned with the talking and laughing when it became loud enough to disturb her focus on the lesson. If students whispered to each other, the teacher

remained focused more on the lesson and did not hear anything. However, some of the student participants revealed that they often talked about chemistry to their friends whom they felt comfortable with. Eileen stated that:

every time I hear any noise, I make sure I stop it straight away because I know it is affecting other students, they may not be able to hear me; causing some confusion of ideas; and those students making noise will never get to learn anything by talking at the same time, I told them ... The only way I use to stop it is to call their names and tell them ana le pisa ... and they stop straight away (Eileen- CS₂TIInt).

The teacher's focus here appeared to be on the execution of the lesson with minimal disruptions so that everyone could hear clearly. In this regard, silence was used to acknowledge respect for others who may be engaged in learning or at least listening to the teacher. Keeping things quiet in class according to Eileen would lead to learning. However, the silence did not last long; the same students who made noise earlier would continue to talk throughout the lesson, despite the fact that Eileen kept on calling their names to stop. She indicated:

I also don't want them [all students] to talk while other students are talking, like when one student answers a question I want all of them to listen to that particular student, but they also talk while a student is trying to answer a question ... because the question was for anyone to volunteer to answer ... often they go quiet ... but when one attempts to answer ... they start to talk to each other or yell out their answers ... I don't want to send them out of class ... they will miss the whole lesson, then more work for me later to explain things to them ... but if they continue this I may have to send them out, let others learn, those who are keen to listen and learn (Eileen- CS₂TIInt).

As students continued to make noise occasionally, the teacher continued calling names without finding out the reasons behind the noise. Although no one was sent out of the class at the time of the research investigation, the teacher was certainly close to doing it. Talking to the student participants about making noise in class revealed that they had a number of reasons for doing so. Sam, who was often called by the teacher to *ana le pisa*, indicated in the interview that:

One time I think the lesson was a bit boring, I was not interested at all, so I was more of looking for something to do, and I started talking to my friend, but very soft ... other times I share what I

know about something with my friend, because I am attending some tutorials at University of the South Pacific, so I get to learn some stuff ahead of what we are doing here, so when the teacher mentions it, I thought I would share with my friend, because she [teacher] explains it differently; the way I know is easier ... sometimes, my friend asks me something about what the teacher says or writes on the board, so I respond and then we continue discussing it, while the teacher is talking until we get caught ... even when I am trying to fan myself [using a book] because it is hot in the room especially after interval ... she calls me to stop (Sam-CS₂S₁Int).

Valeni also revealed in the interview that sometimes he could not understand some of the teacher's words and explanations and therefore:

... instead of asking or interrupting the teacher, I ask my friend about it, because I prefer asking my friend ... and because she told us to aua le pisa, I stopped and listened to her ... what I wanted to find out from my friend was immediately lost; because we were told to be quiet (Valeni-CS₂S₂Int).

Similarly, Joyce indicated that sometimes she talks to her friend about things related to either homework or the notes. She stated in the interview:

I just wanted to confirm some stuff that I did not understand in our homework, so I asked my friend ... but I really don't like when she tells us that [aua le pisa]; we were talking about chemistry stuff yet she stopped us, but we were trying to understand something ... something that we couldn't understand although she already explained. So when she asked questions about it later ... couldn't give an answer to any (Joyce-CS₂S₄Int).

When asked about her views about the teacher using 'aua le pisa' in class, Florence claimed:

I was discussing something with my friend; I was a bit confused when the teacher was talking about something. I turned to my friend and we talked about it. She has a point to stop the noise, but once I see something that is confusing or cannot understand I immediately try to look into it ... I always ask my friend for things that I am not sure of So I wish she tries to find out first before shutting us down (Florence-CS₂S₃Int).

Florence chose to discuss the problem with her friend because she (and other students) preferred asking their peers over the teacher. Therefore they sat next to their friends who they could get help from while in class. Social constructivists' perspective of learning

considers the interactions between students, and with their environment as well as within individual student (Nuthall, 2012). Knowledge and understandings are constructed when individuals engage socially (with peers) involving persons-in-conversation (T. Crawford, 2005). Learning therefore is shaped by social interaction with peers (Driver, et al., 1994; Duit & Treagust, 1998; Rogoff, 2003; Watkins, 2000). However, when the teacher called on them to stop talking to each other, they stopped and began to lose interest and did not either tell the teacher what they were talking about or ask for the teacher's help. Consequently, the chemistry ideas remained unclear. Students learnt that their particular classroom environment does not reinforce social interaction, so they became reserved and silent.

The findings identified in this section revealed yet another misunderstanding between the teacher and the students. The teacher, on one side tried to ensure that the lesson was free of disruptions so that it flowed according to her plan, and assumed that talk among students was off-task. The students on the other hand, often sought help about from their peers whom they felt comfortable talking to. In this regard the students felt comfortable and that it was more acceptable and useful to turn to their peers for help. Unfortunately the strong belief that everyone should listen to the teacher and the effects of the one-way lecture approach led the teacher to constantly use *una le pisa* during the lesson presentations.

5.7 Chapter summary

This chapter provides the findings and the discussion of four key findings from CS2. The data shows that there is a disconnection between the teacher and the students. The disconnection was reflected in the differences in perspectives about the students' preferred ways of learning and the teaching of chemistry. The findings revealed that the students wanted to:

- have notes rather than just sit and listen to the teacher
- more exercise (written tasks) than sitting and listening to the teacher
- do hands-on tasks that make them move around in class
- do experiments to help them become actively engaged.

The findings suggest that the teacher was more concerned with:

- delivering all exam related facts to the students
- the examination and school standards
- the flow of the lesson presentation according to her plan

Lecturing as a method of teaching chemistry was teacher-selected based on her experience and beliefs and school tradition. For instance, she highlighted that such a method was the appropriate one to be used in a large-numbered class, as it allowed her to give more information and a much faster method to cover the syllabus. With regard to her traditional transmissive lecturing approach, the literature states that it is a relatively ineffective pedagogical tool when it comes to promoting conceptual understanding (Knight & Wood, 2005). Wittwer and Renkl (2008) suggested that “explanations that are given in educational contexts qualify as instructional explanations because they are deliberately designed for the purpose of teaching”. Therefore the “learners might only passively receive information without further engagement in elaborative activities” (p. 50). Furthermore, the students become withdrawn from the lesson and become engaged with activities either private (individual) or semi-private (with peers), of which some of them may not be about the chemistry lesson (Nuthall, 2012).

The pressure of the Samoa School Certificate chemistry examination affected the way Eileen taught chemistry lessons. Through lecturing she prepared and gave the exact information for students to answer the exam questions and told the students to learn the information. This means that the students in CS2 were trained to become efficient in surface learning approaches where they memorised and stored facts and reproduced them later. Basically, the teacher thought the students would remember and be able to answer exam questions and pass with outstanding results. In terms of exam results, Eileen believed that she was working to ensure that the students would gain good results in the SSC exam to maintain the standard of the school from the past.

While the teacher focused mainly on the presentation of scientific facts and examination-related information, she also tried to make sure that everyone was quiet by calling *ana le pisa* as described in the fourth key idea. The data shows that the teacher expressed the view that students making noise during the lesson don't learn anything. However, some of the

students were trying to clarify ideas amongst themselves. In this regard, active engagement of students during discussion with peers, some of whom know the correct answer, may lead to increased conceptual understanding, resulting in improved performance (Smith, Wood, Krauter, & Knight, 2011; Kenneth Tobin & Gallagher, 1987). Calling *ana le pisa* appeared to discourage these student to talk to each other, and eventually they became quiet even when they were asked to talk or respond to questions, partly because they could not understand everything.

The next chapter describes the results from Case Study 3 (CS3) and the key findings developed from the data collected are discussed in light of the literature.

Chapter 6 Case Study 3 Results

6.1 Introduction

The results and discussions for Case Study 3 (CS3) are presented in this chapter. It begins with a description of the case. This is followed by the presentation of the results from the case outlining four key findings. The key findings concern:

- The lack of science resources influencing the way chemistry is taught.
- The impact of giving homework everyday.
- Samoan language and chemistry.
- Reasons for not asking questions.

Each key finding is discussed with relevant comments from the participants and attention is drawn to how the findings from this case fit in with the existing literature. Where Samoan language is used, English translations are provided. A summary of ideas is provided at the end of the chapter together with a brief introduction to the next chapter.

6.2 Description of Case Study 3 (CS3)

CS3 was a Year 12 chemistry classroom in a rural secondary school in Upolu. There was only one Year 12 chemistry class offered in CS3, which consisted of nine students, of which two were males and the remainder females. In order to have a representation of a range of abilities across the class, the researcher used their 2009 science achievements to select five students, of which three were females and two males, from the 9 students who consented to take part in the study.

All chemistry and other senior science classes were held in the laboratory room that was furnished with wide, long tables and stools. The stools were almost the same height as the tables so the students seemed to experience difficulties bending downwards when writing, but there were enough for the chemistry class. Similar to the other case studies, the notes were prepared by the teacher in every lesson. However, in CS3 the teacher wrote the notes on the board after the lesson presentation while the students copied them into their notebooks. There were five Year 12 chemistry sessions within a week, each scheduled for 50 minutes.

Evaluation of student outcomes indicates disparities between students from urban and rural areas, with urban students achieving higher English literacy levels (Lameta, n.d). Students in CS3 were often found to have poorer English language skills compare to the other two cases.

The four key findings are presented in the next sections with supporting evidence from classroom observations, student work samples and interviews.

6.3 Lack of science resources influence the way chemistry is taught

This section explores the influences of lack of science resources on the ways Fono taught chemistry in CS3, which constituted a barrier to learning. Based on the information from the participants, science resources refer to the science kits, equipment, chemicals and textbooks for teachers and students. The lack of science resources was found to be one of the major challenges that Fono was facing while teaching senior chemistry in S3 (both in Years 12 and 13). Because of this, he tried several teaching approaches to deliver his lessons. Fono stated in the interview that:

I tried several ways to solve this problem ... photocopied diagrams from textbooks ... gave them [to students] ... I showed some of the movies ... brainstorm ideas on what would happen in an experiment – those [experiments] that we are required to do ... I showed them projects and displays from students last year to help them ... because of lack of science equipment and chemicals ... therefore we cannot do experiments (Fono-CS₃TInt).

Despite his efforts in order to teach chemistry with limited science resources, Fono was aware that “... students did not seem to learn at all ... I felt that I wasted too much time on trying things out, yet they [students] never got to learn anything” (Fono-CS₃TInt). Although science resources were lacking, Fono realised that when it came to experiments that are required in the curriculum he had to find ways for students to experience and learn about the experiment. This was because he realised that “experiments allow student to apply knowledge and understanding to illustrate a concept ... ask questions and make predictions” (Fono-CS₃TInt). Yet the way that he did this did not allow this to happen. Because science resources to conduct experiments were lacking in CS3, Fono instead talked about the experiment. For example in the third classroom observation, he spent most of the 50-minute session describing the laboratory preparation of ethyne:

“Kakou experiment olo’o fia fai, ae leai gi kakou chemicals, o lea ia va’ai mai ma maikau lelei mai le faiga ole kakou lab [activity] lea ... ana ge’i kusia ā se mea, va’ai mai uma i i ... Mana mai?” (Fono-CS₃TCOFN₃) [We have an experiment to do, yet we don’t have the chemicals, so look up and learn how the experiment is to be carried out ... do not write anything, everyone look here ... Get it?]

While talking about the ‘aim, apparatus and procedures, equipment set up, observation and results’, of the experiments, he put up a colourful sketch of the experimental set up – drawn on newsprint which he used in his introduction of the experiment. The same diagram (Figure 6.1) was collected from the work samples, but it was drawn in black and white (pencil).

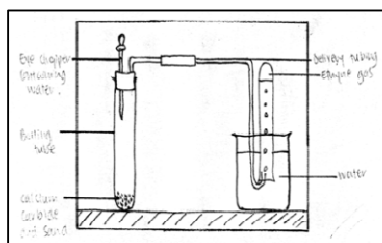


Figure 6. 1: A portion of work sample collected from student Malia (Malia-CS3S1WS1).

In an interview, Malia was able to tell me what the diagram illustrated. However, when asked for an explanation whether the collected gas in the diagram (Figure 6.1) is saturated or unsaturated, Malia paused and looked at the diagram. She then said, “saturated? [and smiled] ...oh wait no, it is unsaturated?” (Malia-CS₃S₁Int). Malia was not sure of the correct answer although she was able to give explanation of the set up, the products and even the chemical equations for the reaction. Despite the confusion in the two concepts, the diagram was however clear and colourful when it was presented in one of the observed lessons. On the basis of the researcher’s experience as a chemistry teacher, the different colours used in the teacher’s diagram seemed to indicate the colour of the chemicals. For instance, the greyish-white colour used for the solid powder inside the test tube represents an impure calcium carbide. Unfortunately the students were not informed about the significance of the colours. The students only admired the colourful diagram and used only pencil to draw theirs in their notebooks and so it became black and white. During the third classroom observation student Dianne said:

“Seki a le aka” (Dianne-CS₃S₄COFN₃) [Translation: Cool diagram.]

In the same classroom observation, Fono started the lesson by reviewing the properties and the chemical equation for making ethyne gas. He often said to the class that “science tells us how things work and ... with laboratory experiments that help us see how these things work” (Fono-CS₃TCOFN₃). In the interview he stated that:

I told them [and] ... gave examples and simple notes ... but they didn't seem to get it. So ... doing an experiment ... they would see exactly what I told them ... but because we lacked resources and equipment ... I could only write out the experiment, diagrams and tell them what happens ... at least they get to experience the experiment in that way ... better than not doing it (Fono-CS₃TInt).

In terms of notes and textbooks used in the teaching of chemistry, Fono stated that:

... I am very cautious when it comes to preparing the notes for them to copy into their notebooks ... brief and simple English and short ... I try to use the exact translations of the words that we use during the discussion ... the problem with textbooks ... language is too hard for them ... I invite them to use the textbooks on my table ... most of the times they don't ... because there is no textbook made specifically for our curriculum ... we use many different ones ... and students are discouraged to look from one textbook to another ... and they can't afford to buy all these too (Fono-CS₃TInt).

When asked in the interviews about their learning experiences when an experiment was presented verbally, the responses from individual students indicated two distinct viewpoints. The first reflected the amount of information while the second focused on the ways science and other subjects are taught as they experienced in their school. The former was identified by Malia and Tamatoa, while the latter was indicated by Tiana, Mary and Dianne. According to Malia:

In the beginning [of the year], our teacher told us that it was going to be fun and heaps of exciting experiments to learn and experience in chemistry ... but we had not experience any, we listened to him telling us the experiment. It takes a lot longer for me to learn through this way, I mean, if I see and do the experiment I can learn it faster and understand it well, but listening to him and reading so much information that he gives us, takes a longer time for me to understand and to learn it ... but I want to know more, better understanding to help me reach my goal in the future ... becoming a doctor ... in my village (Malia-CS₃S₁Int).

Similarly, Tamatoa stated that:

I don't learn anything, when he explains or tells things ... too much information ... and he expects us to learn all that ... some of the stuff is new ... cannot really relate to them ... hard to find the relationship between some of these ideas ... so I can either just sit and pretend that I am listening or read my notes from other lessons (Tamatoa-CS₃S₃Int).

The information from these two students suggests that their attention and capacity to process the information about an experiment is selective and limited. Because there was too much information being told and they were unable to make connection between the ideas, these students seemed to take a longer time to process and come to some understanding of what the teacher was talking about. Sweller, Ayres and Kalyuga (2011) referred to this as 'cognitive overload' where the learner is not able to retain content and having to reread material several times in order to retrieve it. Furthermore, the students find the information new or unrelated, which may lead to attentional shifts and distractions (Roda & Thomas, 2006). This may contribute to the reasons why some students do not learn what the teacher is trying to teach in class.

The three students Tiana, Mary and Dianne shared their opinions in the interviews about the way chemistry as well as other science subject lessons were taught.

I think it's just the ways we do things here in our school, even other science classes [biology and physics]; we are simply given the correct information about science concepts ... honestly I struggle ... so hard to understand ... so I feel sad at time because I might not reach my goal ... a doctor (Tiana-CS₃S₂Int).

All teachers here [school] teach like that, the same ... everyday ... hard to understand anything ... therefore I am still not sure of what to do in the future (Mary-CS₃S₃Int).

It is the same way we do our lessons, experiment or no experiment, he gives us everything and then we have to copy ... that is why I really want to become a teacher in the future, I want to help those students that are struggling ... like me ...but afraid of asking the teacher ... or hard to understand the notes ... anything (Dianne-CS₃S₄Int).

In summary, the lack of science resources in CS3 influenced the way Fono was teaching chemistry particularly in the case of laboratory experiments. Fono was simply telling the students about the experiment including what would happen and the outcome. Presenting the laboratory experiment in this way was the only option for Fono to ensure that the students came to know about an experiment and to gain an understanding of the concepts. Unfortunately, simply telling is not enough to gain understanding (Glaserfeld, 1989; Schwartz & Bransford, 2009), because understanding is not a matter of passively receiving but of actively engaging in making sense of the information. In this regard, when conducting an experiment to explore chemistry concepts, students are involved in actively constructing rather than receiving ideas (Kang & Wallace, 2005; Kipnis & Hofstein, 2008; K. Tobin & Llena, 2010). Moreover, the students are given the opportunities to gain access to various learning skills (such as observation, handling apparatus, measuring) (Chinn & Malhotra, 2002; Hofstein, et al., 2004; Shulman & Tamir, 1973), which may become useful in tertiary education where there is a high requirement for laboratory and experiment familiarity (Soti & Mutch, 2011). However, these opportunities were not available in CS3 because of the lack of science resource. As a result, the students in this study experienced difficulty in processing the large amount of information and were unable to connect relevant ideas despite Fono's claim that "experiments allow student to apply knowledge and understanding to illustrate a concept, ask questions and make predictions" (Fono-CS3TInt).

6.4 The impact of giving homework everyday

Classroom observation in CS3 showed that there was homework for students to do every day. However, the students found it difficult to complete and learn from the homework because they could not understand it and this was a barrier to their learning. The homework was all in English which comprised of short and long answer questions and students were to answer in words or statements. As well, there were some questions that required students to do mathematical calculations. In this section, we look at the purposes and significances of giving homework on a regular basis as Fono indicated in the interview:

Practice makes perfect and the more you practise the better it gets. This is simply the purpose of giving homework. I want them to practise ... go through the stuff we discuss in class and then ... answer the questions or solve some problems ... that is why I get really upset if they come back and

say that they have not done all of it or forgot to hand in their assignment book ... but they are short tasks that they can do at night and bring it in the next morning (Fono-CS,TInt).

Do you think that practice enables the students to understand the materials included in the homework, how do you find out if they do? (Researcher)

I believe [that] they eventually come to a point where they understand the stuff, but very much depends on how much times they spend on the questions and the notes. You know the nature of Samoan students, they are lazy to read [and] therefore they cannot construct new ideas from a piece of information. They take shortcut which often leads them to more problems, but I know all of these shortcuts. In order to avoid taking shortcuts I give directions, guidelines about what to do consistently. And all these directions are embraced in the homework activities. If no homework, they will never go back and re-read what we went through today. I believe that homework stimulates studying at home (Fono-CS,TInt).

How many times do you think your current chemistry students need to practise in order to understand? (Researcher)

It should only take them a couple of times to go through and be able to understand. I keep things simple because I know that these students [in rural schools] are weak in subject content as well as poor English language proficiency. Giving them homework every day will also help them to develop their skills of answering questions, and how to respond by giving the exact answer. These skills could be used in other homework, and so on. I want them to continue developing their knowledge and skills in chemistry (Fono-CS,TInt).

Fono's emphasis on the role of homework is mainly on practice. In this sense, according to Epstein and Van Voorhis (2001), homework is designed to give students opportunities to practise skills taught in class, increase speed, demonstrate mastery, retain skills, and study for tests. There is obviously some truth to the idea that practice is connected to proficiency. Nuthall (2012) summarised that:

as children become familiar with an activity, they do it and build up a mental image of the process and the structure of the activity. The mental image includes all essential aspects of imitating the activity which can then be used to play and replay

the activity in the mind in order to try out and predict their outcomes internally (pp. 2-3).

However, people who practise by doing something a lot, often get better at doing it, but this does not mean that they understand it, “because practicing does not create understanding” (Kohn, 2006a, p. 1). To elaborate on the idea of practice without understanding, Dianne described during the interview that:

... my answer here [refer to homework sample] is wrong ... so if asked again, I know that ethene gas is unsaturated (Dianne-CS₃S₄Int).

Although Dianne was able to identify the correct answer to the given question, she could not provide explanations when asked why an ethene molecule is considered an unsaturated hydrocarbon. This example illustrates that doing homework provides an opportunity for Dianne to remember the right answer particularly for two choice questions types without any understanding of the chemistry concepts. Thus, practice through the use of homework, as in the case of Dianne, appears to produce a specific behaviour rather than understanding (Kohn, 2006b). Behaviourism regards this kind of learning as a stimulus-response process: where memory, previous organisation of content, repeating and exercising; are the key elements for achieving knowledge (A Bandura, 1989; Duit & Treagust, 1998). It considers learners as a *tabula rasa* in which one can write information that can be changed by experience. So in order to justify sending students home with a worksheet full of practice problems on the grounds that it reinforces skills is to say that what matters is not understanding but behaviours that will help them pass tests and SSC.

While the teacher talked about homework as a way for students to practise, the students raised during the interviews very different perspectives on both the value of doing and the difficulties that they experience while doing the homework:

I like homework especially if I know what is going on. Our homework is based on what we do in class, or on the notes that we copy from the board, unfortunately not every day I understand the whole lesson. So if I don't understand a lesson, it is very hard to do the homework and it is frustrating ... In cases like this, I will go to the next village, there is a university lecturer there and ask her for help. She will explain and tell me the answer to the questions (Malia-CS₃S₁Int).

I don't know why only our chemistry teacher gives homework every day. Most of us don't get to complete because I could not make a connection between the material we talked about and the question ... like tricky questions (Tiana-CS₃S₂Int).

Really, I think it is too much work for us. First we try to understand so much notes that we copy from the board, second, we have other subjects' notes to read; third, there are homework for those other subjects and internal assessment tasks; fourth, we do chemistry homework every night ... we also have duties to do after school at home ... if we miss one we get scolded ... too many errors he scolds us ... too many times ... and I am not happy when he does that (Mary CS₃S₃Int).

Homework is good to help us practise our chemistry but I wish the teacher can spend some time in class to explain each question. So I try to get my mother to translate for me, but she cannot understand. I ask my friend from our class, but she also doesn't understand, so I leave them with no answer, although the teacher always smacks me on the head for incomplete work ... makes me really want to become a teacher in the future so that I can help students like me (Dianne-CS₃S₄Int).

I don't really enjoy doing homework at all but I try to do it, because we have to ... [but] sometimes I could not finish, because I could not understand the questions. Sometimes I don't get to do it until very late at night, because ... boys do more chores at home ... usually I fall asleep while looking at the homework late at night ... makes me feel that I don't know why I am in school ... like no place for me ... I don't know (Tamatoa-CS₃S₃Int).

Giving homework to do every day is considered important by the teacher. This is because he thinks that doing homework provides a practice for students to become better, although the data suggested it was more a case of rote learning of answers without understanding. For students, doing homework every day does not necessarily help them understand, because sometimes they could not understand the lesson and the homework. One of the student participants could not find time at home to do the homework, because he spent his after-school hours doing house chores. Despite the lack of enthusiasm, the students still had to try to complete the homework for the teacher to assess.

6.5 Samoan language and chemistry

The use of Samoan language in CS3 was a support for learning chemistry concepts, however when it was a barrier to examination achievement because English is the language of assessment in Samoa.

The language of instruction used in CS3 was predominantly Samoan. Fono spent most of the 50-minute session explaining the lesson in Samoan while retaining English terminologies of the chemistry concepts. He also allowed students to respond in Samoan or English but most of the lesson was in Samoan language. Because of the difference in medium of instruction in CS3 and the other two case studies, it was important to explore why Fono chose to use Samoan language to present the lesson and to find out how students felt about the use of Samoan language in the teaching of chemistry.

Fono was excited to share his viewpoints when asked about the reasons for using Samoan language when teaching the three lessons. Immediately he said:

This is a really good question and I have a lot to say about it ... I deliberately chose to use Samoan to teach ... although our books and curriculum are in English. I believe that using our mother tongue to explain is the first point of contact with the students, in a way that is familiar to them, with which they can become part of it. From my [past teaching] experience, I entered the class and started speaking in English, the students looked around [they] gave no response at all. Nowadays with the use of Samoan language students slowly understand the material, they participate in class discussion; they answer in Samoan; some are able to mix English and Samoan (Fono-CS₃TInt).

Fono's views are in line with arguments presented elsewhere that people in Samoa should be able to participate in any social contexts using the language that they can speak and understand (Lameta, n.d). In CS3, the students are provided with the opportunities to participate through the use of Samoan language. A typical illustration comes from field notes taken during the second classroom observation where the teacher was talking to the students:

... "o saturated compound o loga uiga ua 'ako'akoa le compound lea, ua le koe iai se avagoa mō se isi atom e koe mafai oga pipi'i aku ile compound fa'ata'ita'iga ole methane" ... he then drew the structure of methane (Figure 6.3) on the board ... malamalama? (Fono-CS₃TCOFN₂)

[Saturated compound means the compound is full there is no space for any other atom to bond to the compound, for example, methane ... Understand?]

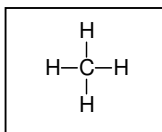


Figure 6. 2: Structure of methane drawn on board (re-drawn for better visibility)

Fono continued explaining with reference to the drawn structure:

“Ole carbon a lakou ia e ga ole fa lava bonds, a’o lea ua fa’akumu uma le fa le ga e hydrogen atoms e fa ... loga uiga ua saturated le methane, maua mai?” (Fono-CS₃TCOFN₂) [Carbon only has four bonds, and now they have been filled up by four hydrogen atoms, so this means that methane is saturated, get it.]

In addition, students talked to each other using Samoan. Tiana in the interview confirmed that:

... when I talk to my friend I use Samoan ... my friend also uses Samoan when she asks me ... all of us do, when we talk to each other (Tiana-CS₃S₂Int).

In the interview, Fono indicated that students develop misconceptions due to the lack of understanding of English language. He claimed that:

These students struggle to understand chemistry concepts and the relationships of specific concepts. Some students are able to understand simple English ... words that we often use in our daily activities, but when we explain things like properties of hydrocarbons, then we get to use words like saturated or unsaturated, melting and boiling points, chemical or physical reactions ... I believe that this is why students make misconceptions; chemistry concepts are not clear because they [students] did not fully understand the language of instruction (Fono-CS₃TInt).

What are you doing in order to promote conceptual understanding and avoid making misconceptions? (Researcher)

I use our [Samoan] language to clarify all these technical terms ... and then as we go along, I slowly repeat what we went through in English ... for the exam and their internal assessments ...

at the same time our fa'a-Samoa is maintained ... students interact in class in Samoan, they can freely speak and discuss using our language (Fono-CS₃TInt).

So how much time do you spend on repeating the same stuff in English, is it enough to help the students with their homework? (Researcher)

The most important and the first thing is to understand through the use of our language. Most of my lessons I use 10 to 15 minutes because surely they have understood the stuff when I explained in Samoan ... but varies based on how long and whether it is a new topic or not ... however I really wish that the students could come to me for clarification before they go home ... I am sure as they copy the assignment into their exercise books, they would pick up areas of concern, then come and see me even in their free time, interval or after school ... I don't know why they whisper to each other sometime ... I want them to ask me ... I am here to help them ... any time is fine ... but talking to one another too often I have to stop them ... because that means they are talking about silly stuff (Fono-CS₃TInt).

The language of instruction according to Fono is an important element to his teaching and thus the Samoan language was selected. This is because Fono believes that the students are comfortable with it and can understand it better. It is the language that they speak at home that Smits, Huisman and Kruijff (2009) argued that relates to children's achievement in school. Language is absolutely essential to learning but the current situation in CS3 is that the teacher's teaching is predominantly Samoan, but assessment of students and questions in the School Certificate examination are entirely in English. The students might have an understanding of the chemistry concepts but may not be able to show that understanding in the examination because of the language of the exam.

When the student participants were asked whether the use of Samoan language in chemistry helped them in their understanding of chemistry concepts, three responded positively, one negatively and one did not comment. Positive comments related to the relevance of information and ease of recall, while the negative comments identified disadvantages of Samoan when it came to responding to questions in tasks and examination. For relevance of information and ease of recall, Tiana, Mary and Tamatoa respectively indicated that:

I find it easier and faster to understand the materials ... if the teacher explains them in Samoan ... as opposed to when English is used ... the stuff that we hear in Samoan [language] helps us to understand all the notes given because they are all in English ... this is very helpful ... but I think maybe more time to process all ... before moving onto new topics (Tiana-CS₃S₂Int).

Very helpful ... the use of Samoan language to explain chemistry ... makes it easier to understand ... easy to remember ... when the teacher asks a question, the thing that comes first in my mind is the Samoan explanation ... we should get our notes in Samoan too ... but ... only ... copy the notes from the board ... all in English (Mary-CS₃S₃Int).

It is a lot easier for me to make sense of these ideas if are in Samoan; I can understand and then try to find the English when I write ... most of the times the notes are in English language but we already discussed them in Samoan ... he gives translation too some-times ... I just wish we can use Samoan in the exams (Tamatoa-CS₃S₃Int).

The disadvantage of Samoan language was revealed by Malia. She said

I find it problematic when it comes to assessment ... although I have some knowledge from the explanation ... it is still a problem when it comes to writing answers to questions ... too much use of Samoan language restricts my English vocabulary ... hard to write in examination (Malia CS₃S₁Int).

When talking to the teacher about the language to use when answering questions in the examination, Fono said:

... I told them to try and use English when answering questions [in exam]... but sometimes ... I accept answers in Samoan (in homework) ... not the language but if the concept is correctly used ... I think is ok ... but am not so sure about the Ministry ... allow it or not [in SSC exam] (Fono-CS₃Tint).

Fono was aware that students had some issues when expressing their conceptual understanding during class discussion and tasks. Talking to the student participants, four revealed that expressing ideas or answering questions in English is an issue. Here is what they said when asked about the use of English to write answers to questions.

I try to answer some questions ... but if I don't know the exact [English] word then I try to think of another word to describe what I want to say (Tiana-CS₃S₂Int).

When doing homework, I read the question then I search through the notes for the words that are in the question then I try to answer from there. Normally I will just write what is given in the notes ... but for exam ... I answer the ones that are easy for me ... like A, B or C ... or the matching ones (Mary-CS₃S₃Int).

Very hard to write [English] words ... don't know what word to use and I cannot really spell ... sometimes if I can remember the sound of the word then I try to spell ... if it is a correct answer ... the teacher marks it correct (Dianne CS₃S₄Int).

Fono realised that English language was a concern to the students and therefore he tried his best to ensure an English word was understood if he used it in any of his presentations. In one of his comments in the interview, he stated that:

This particular student, Tamatoa has very ... poor English ... sometimes he just writes the question as an answer ... so I spend ... time to read all that he has written to see if his answers were correct ... in class, he seems okay when using Samoan, so if I use English language I make sure I repeat it many times and write on board so that he and others could see (Fono-CS₃TInt).

According to Tamatoa:

I try... to translate what I hear in class ... I write anything down if it is a test ... if there is a question that I know the answer in Samoan, I will try to find the English words ... if not ... I use Samoan ... for the homework ... I use the notes ... that we have to copy to help me ... but since they are all in English ... always difficult to do the task (Tamatoa-CS₃S₃Int).

The data showed that Samoan language was predominantly used to teach and give instructions in CS3. Rowe (2004) stated that social constructivism places prime importance on the pedagogies of social interaction of the people involved and the fact that learning is mediated by their own language. Many studies in science education (for example: B. A. Brown & Ryoo, 2008; Chin, 2007; Martin, et al., 2009; Mortimer & Scott, 2003) share the perspective that development and learning involve a passage from social contexts to individual understanding (Vygotsky, 1978) and that language is basic to the development of

thought. Johnstone and Selepeng (2001) compared the amount of working memory space available for a first and second language learner. Basically, the use of the learners' first language allowed more working space for processing and making sense of the materials (Johnstone & Selepeng, 2001).

Despite acknowledging the crucial role of the Samoan language to promote understanding of chemistry in CS3, the notes, tasks, resources, assessment and the official language of instruction in secondary schools use English language. The findings suggest that the student participants in CS3 struggled to identify English words when expressing their answers orally or in writing. They may have understanding of the chemistry concepts but are unable to show that understanding in the examination which may become a barrier to their achievements in chemistry.

6.6 Students' reasons for not asking questions

Observations of three chemistry lessons and interviews with the participants revealed that students had various reasons for not ask the teacher questions and these became barriers to their classroom learning. Some of the reasons suggested by the student participants are consistent and/or an expansion of the ideas in the literature. For example, Samoan and other Pasifika students are generally too shy to ask questions (B. Osborne, 2001). Fanene's (2006) study of New Zealand-born Samoan tertiary students found that they don't ask questions because they have a lack of confidence. In this study, the students revealed more reasons for not asking questions than just being shy and lacking of confidence which is different to those held by the teacher.

From the interview with Fono, three significant factors emerged in relation to his perceptions of why students were not asking questions (see Table 6.1). These include school practices and experiences, home and cultural practices and religious experiences and biblical values.

Table 6. 1: Teacher perceptions of why students did not ask questions

<i>Ideas</i>	<i>Comments from Fono during interview</i>
1 School practices and experiences	<i>[Because] most students don't ask, I ask if they have any questions but they never did which is not good ... the fact is that ... if a student begins high school with this habit of not talking, it will be too hard and too late at the higher levels [Year 12] to change ... at that age [refers to primary levels] ... children talk a lot, curious, so they should be encouraged at that level ... but often teachers shut them down ... they come up here they are aware that they should not talk or ask questions.</i>
2 Home and cultural experiences	<i>Our culture and practice every day is another barrier, at home children are often shut down immediately if they ask questions to adults, it is disrespectful ... they are told not to speak in the midst of adults but only with other children ... so when the child enters these doors, it's programmed in their heads, that the teacher is an adult, no talk ... can only talk with other students.</i>
3 Religious experiences and Biblical values	<i>Samoans go to church; we listen to the pastor whom is the messenger to tell us the word of God ... we teach our children Biblical values ... For example Matthew 11 says ... 'be who has ears to hear, let him hear' ... Proverbs ... says 'stop listening to instruction, my son and you will stray from the words of 'knowledge', see there is that aspect of listen ...</i>

Often in the three lessons, after a long and intense presentation of details of chemistry concepts, the teacher would immediately ask students “*e iai se fesili?*” (Any question?). The students may not be able to come up with any questions as they are simply presented purely with facts about chemistry concepts with little time to think about the concepts and formulate questions. Chin and Osborne (2008) argued that questioning is one of the thinking processing skills which is structurally embedded in the thinking operation of critical thinking, creative thinking and problem solving. In contrast, Fono’s request for questions was always unproductive and students never formulated questions as the teacher intended. When talking to the students about the notion of asking questions in class, two very different reasons, compared to those held by the teacher, were revealed. The first is ‘fear of the teacher’ and the other is ‘fear of being stupid (see Table 6.2).

Table 6. 2: Students’ perceptions of fear about asking questions

<i>Form of fear revealed</i>	<i>Student participant</i>	<i>Comments from student participants during interviews</i>
Fear of the teacher	- Malia	- <i>I am scared of him ... if I ask I am afraid he might beat me up ... I've seen him beating up kids ... so I really don't want to mess up with this guy ... what he teaches I try to learn ... things to do I make sure I do well</i>
	- Dianne	- <i>He scolds us ... he gets really upset ... like if I ask I still don't understand functional group after he had gone through it ... he gets really upset ... and tell us that we do not study hard enough</i>
	- Tamatoa	- <i>If I ask questions, the teacher might feel that I am fiafoko [be conceited, arrogant] ... we are given everything ... asking a question yet we are given everything is considered fiafoko ... I will get it somehow later</i>
Fear of being stupid	- Tiana	- <i>I am afraid because I don't know what to say ... what words to use ... what to ask for ... I might say the wrong words ... then he ask me more questions ... and make me more confused and look stupid</i>
	- Mary	- <i>I feel that I put myself on a spot if I ask a question ... teacher will stop talking ... students looking at me ... everything goes quiet ... but here I am trying to ask a question ... my heart pumps so fast ... many things rushing round my mind ... breathing go faster trying to push out the first word and the next ... is this the right question to ask ... am I asking something about this lesson or something that we never done before ... how are other students thinking ... they probably know the answer already ... I don't like ... and I will not even try it [to ask question.]</i>

The data in Table 6.2 shows that students demonstrated reluctance to speak or ask questions of the teacher because of fear, both of the teacher and of looking stupid in front of the class. Experiences that these students went through have contributed a lot to their present practice. For example, Malia talked about physical punishment that was not evident at the time of the investigation, yet the perception that it occurs has developed into a barrier to asking questions. Physical punishment has been outlawed in schools in Samoa (Pereira, 2010). Scolding and shouting was used by the teacher during the research investigation and its use seemed to have become automatic. If a student was caught looking outside, the teacher would switch to the scolding or shouting approach including contemptuous comments just as Dianne has reported.

The teacher’s own perceptions of the reasons why students do not ask questions (Table 6.1) were different to those held by the students (Table 6.2). For students, shyness reflects the Samoan cultural practices and religious beliefs held by the students (young people) that

discourage them from speaking up or challenging the adults. The students' lack of confidence in the subject content as well as in the English language developed the feelings of fear of looking stupid in front of the class. Research shows that students would be well served if teachers acknowledged that learning in science is often based on a struggle to reconcile ideas and observations and is not just memorising facts (DiCarlo, 2009; Kraft, 2010; Songer & Linn, 1991). As such, knowledge and understandings, including scientific understandings, are constructed when individuals engage socially in talk and activity about shared problems or tasks. Making meaning is thus a dialogic process involving persons-in-conversation (T. Crawford, 2005), and learning is seen as the process by which individuals are introduced to a culture by more skilled members. "The teacher encourages students to put forward their ideas [and ask questions], explore and debate points of view, and students' responses are often tentative suggestions based on open or genuine questions, spontaneous, and expressed in whole phrases or sentences" (Chin, 2007, p. 816). The findings of Case Study Three paint a different picture

6.7 Chapter summary

This chapter describes the results according to the four key findings concern: (i) lack of science resources influence the way chemistry is taught, (ii) the impact of giving homework everyday, (iii) Samoan language and chemistry and, (iv) reasons for not asking questions. These are briefly discussed in light of the literature.

The lack of science resources affected Fono's teaching of chemistry. Instead of doing the experiment as it should be in any science classroom, the teacher presented the information about the experiment. However, the students were presented with a good deal of information to read and understand. Because of too much information and the inability to make connection to and between the ideas, students experienced cognitive overload and required a longer time to process in order to understand (Sweller, et al., 2011). Such time was typically not available.

Giving homework to do every day was considered important by the teacher. The purpose was for students to practise what they have discussed in class and according to the teacher if they practise more they become better at doing these kinds of tasks and understanding the material. The findings showed that, instead, the homework resulted in rote learning

without understanding and often students were faced with questions they did not understand.

Another significant finding was the predominant use of the Samoan language to teach chemistry and give instructions in CS3. The use of Samoan language was perceived by the teacher and students in CS3 to be useful in promoting understanding of chemistry ideas. While it was used to teach and explain chemistry ideas the curriculum, books, notes and questions in the examination are written in English. The students find it difficult to understand the question and to identify the correct English words when answering. The finding showed that there is a tension between English being the sole medium of instruction and examination use in secondary schools (except Samoan as a subject) while the students (especially in the rural schools, i.e., CS3) are struggling not only with the language and concepts of chemistry but also English as the language of instruction.

Two different viewpoints about the reasons for not asking questions (or barriers) were also revealed. The first set of reasons was suggested by the teacher. The teacher thought that the students should be encouraged to talk and ask questions while in their primary school levels. So by the time they reach secondary level, they have gained some confidence in asking questions. However, the teacher reported that the students were not given any opportunities to ask question in primary school level. He also considered the influence of the Samoan culture upon students. For instance, they are told at home that asking questions to adults is considered challenging and disrespectful. Therefore students tend to remain quiet, not asking questions when they are with adults at home as well as in the classroom. The teacher also identified religious and biblical values acting as barriers to asking questions.

The second set of reasons came from the students and concerned fear: fear of the teacher and fear of looking stupid. The fear of the teacher is an emotion induced by a perceived threat (involving the teacher) that causes the students not to ask. The finding showed that the students might have seen physical punishment being performed by the teacher and thus their response was to avoid asking in case the teacher got upset and punish them. The students also assumed that asking questions may be perceived by the teacher as arrogant. Students were afraid and worried about being wrong or seeming stupid by asking

questions, despite having been presented with copious amount of information. As a result, students remained quiet and waited for the opportunity to seek help from their class-mates.

In the next chapter, common and distinctive ideas across the three cases are synthesised; their meanings in terms of the aim of the study and what can be learnt from it are discussed with reference to the literature.

Chapter 7 Discussion – Cross-case Analysis

7.1 Introduction

The main focus of this study is on support for and barriers to students' achievement found in three Year 12 chemistry classrooms in Samoa. Inherent in this focus is the importance of seeking out teachers' and students' perspectives on teaching and learning as well as the way classroom teaching and learning occurs. The cross-case analysis of the factors that act as supports for and barriers to students' achievements reflect elements relating to the Samoan culture, the institution and the classroom. Thus, the discussion in this chapter is in three sections according to the factors illustrated in Table 7.1.

Table 7. 1: Factors influencing student achievements in Year 12 chemistry in Samoa

<i>Samoan cultural viewpoints</i>	<i>Institutional factors</i>	<i>Classroom factors</i>
<ul style="list-style-type: none">• <i>Fa'a-Samoa</i>	<ul style="list-style-type: none">• Lack of sufficient science resources	<ul style="list-style-type: none">• Lecturing to deliver exam related facts to students
<ul style="list-style-type: none">• Samoan language to teach chemistry to students with low English language proficiency	<ul style="list-style-type: none">• Lack of science textbooks tailored for the Samoa Year 12 chemistry curriculum	<ul style="list-style-type: none">• Tasks to practice skills necessary for exams
<ul style="list-style-type: none">• Samoan language in assessment		<ul style="list-style-type: none">• Peer interactions• The amount of information in any one lesson.

The discussion in each section demonstrates how the findings fit within the body of literature related to the area of study.

7.2 Samoan cultural viewpoints

The factors relating to the Samoan culture revealed in this study relate to several key components of the *fa'a-Samoa*, and the use of Samoan language to teach chemistry. *Fa'a-Samoa* is the total make-up of Samoan culture, comprising of both visible and invisible characteristics, values and beliefs that influence and control actions, behaviour and attitudes of Samoan people (Silipa, 2008). Central to the Samoan culture is its language

which gives meaning to all social and cultural relationships between groups or individuals within the Samoan communities (Hunkin-Tuiletufuga, 2001).

7.2.1 Fa'a-Samoa

The key components of *fa'a-Samoa* revealed in this study include cultural aspects of *fa'aaloalo* (politeness, mutual respect and social collaboration between people), and *vā fealoa'i* (the sacred space between individuals). In this study, the teachers believed that when students practised these cultural aspects inside the classroom, they became barriers to their learning. In contrast, students expressed their belief that these cultural aspects are important and must be maintained throughout their learning experience. This belief was apparent in their observed behaviours. Important in these cultural aspects is the display of respect by lowering oneself, and not challenging or questioning the ideas that are presented, especially from an adult, a leader or a person who has been chosen for a role, such as a teacher. Basically the children are exposed to such practice, and when they become adults, leaders or someone with a role; they will continue to practise these important Samoan cultural aspects.

Across the three cases, the data from some of the five students in each of the three classes revealed that they held strongly to their Samoan cultural beliefs of respect and observing the *vā fealoa'i* in the chemistry classroom. All from CS3, one from CS2 and some from CS1 revealed that they observed their *vā fealoa'i*. They realised that asking or challenging the teachers' comments was disrespectful and rude. In this regard, some of the students experienced enormous discomfort if they breached what their parents had taught them. As Tamatoa (CS₃S₃) claimed, he was told by his parents to listen to but not to question the teacher. Before students enter the classroom, they have already developed in their minds an idea which can be referred to in this study as a 'cultural rule' to be followed until they become adults or leaders. In order to show respect, the study revealed that the students displayed agreement and acceptance to all that was said or presented to them by their teacher (an elder or a leader). Results from a study in a science classroom in Hong Kong suggests that the concept of 'filial piety' in cultures prevents students from challenging the authority figure in the classroom (Thomas, 2006). Other studies also indicate that such practice promotes behaviour in children whereby they are obedient to their teachers (or

elders), irrespective of the demands or requests made (Gow, Balla, & Hau, 1996; McManus, et al., 2003).

In addition to this cultural rule appearing to be strongly upheld by most of the students, two of the teachers, Malaki and Fono, reported in their interviews that it was one of the reasons why students did not voice any concerns, asked questions, or made any comments about a chemistry idea, the lesson, or the notes. Knowing that the students were unlikely to breach this cultural belief the teachers' only perceived option observed during the classroom lessons was to complete the curriculum requirements. In addition, the teachers continuously present students with the information that they believed it was necessary in order to pass the exam. However, the data from the three cases revealed that most of the students did not understand the content of the lesson and instead of asking the teacher (seen as culturally inappropriate), they asked their peers when seeking clarification.

Social constructivists work from the presupposition that knowledge develops and exists in a cultural context, which include both the culture of science (and science education) and the cultures of the people that science (and science education) are intended to serve (Cobern, 1998). Basically the cultural aspects of *fa'aaloalo* and *va'fealoa'i* held by the students needed to be taken into consideration, rather than being ignored or sometimes criticised. For instance, Malaki and Fono were aware of the existence of these cultural aspects and their impacts on students' learning, yet in the interviews they stated that they wanted students to ask questions. This was evident during the classroom observations when the teachers often asked students to comment or ask questions. Despite these requests, the students chose not to challenge their teachers through questioning (seen as being culturally disrespectful), but to stay silent or to ask their peers.

The use of Samoan language ensures that learning is part of *fa'a-Samoa* which embeds “three important components [*va'ai, fa'alogo, tautala*] in relation to learning” (Alefaio, 2007). Transforming the ideas of Alefaio to fit with the current study, a model (Figure 7.1) was developed where *fa'alogo ma va'ai* are incorporated within the first component, *mafaufau ma fa'aaoga* in the second, and *tautala ma fa'ailoa* in the third component. This model tries to demonstrate that if Samoan language is used, the students may learn and participate in science learning through the three components.

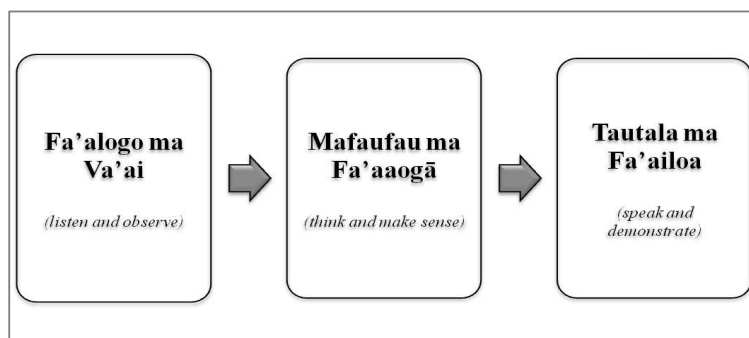


Figure 7. 1: Learning is part of Fa'a-Samoa (Ideas adapted from Alefaio, 2007)

In the Samoan context *fa'alogo* is listening/hearing, receiving instructions or being compliant (Alefaio, 2007) with what is going on in the classroom or any other setting. *Va'ai* refers to seeing or observing visual presentations of things. Both *fa'alogo* and *va'ai* occur during the oral presentation of the chemistry lessons. At this stage the students are introduced to the information, topic or lesson as it is in the introductory phase of the IEP model (Figure 7.2).

The students were often asked to *mafaufau* (think), and to conceptualise by making sense (*fa'aaoga*) of the information, ideas or concepts that they heard and saw in the class/lesson. For instance, the teachers asked questions in class or provided written tasks for students to do. Students who were able to explore and process the information within the given amount of time were able to come up with answers to the questions. *Mafaufau and fa'aaoga* take place in the exploratory phase of the model while the last phase is where students gained confidence in speaking, telling (Alefaio, 2007) and expressing views about what they had learned. If students were allowed to use a language that they were comfortable with, while speaking (*tautala*), they could bring out various ideas and ways of describing and explaining to demonstrate (*fa'ailoa*) their own understanding of a particular idea or situation. Indeed, the demonstration of their knowledge and understanding could be in the form of writing or orally, just like how a Samoan orator expressed his understanding in addressing an issue/situation or arguing a case.

7.2.2 Samoan language to teach chemistry to low English language proficiency students

The Samoan language was identified as supportive to learning chemistry by Fono and most of the students in CS3, particularly in circumstances where the English language proficiency of students was considered low. These rural students found the chemistry difficult to understand because they could not understand the chemistry concepts when they were explained in English. One way that was identified to be helpful to gain understanding by the teacher and students in CS3 was the use of the Samoan language. However, some of the students in CS3 were concerned about the difficulty in transferring their understanding of the chemistry concepts in the Samoan language into the English language when completing internal assessment tasks and answering exam questions. This is discussed later as a barrier.

The use of Samoan languages as the required medium of instruction by Fono and most of the students in CS3 resonates with an official statement from UNESCO meeting of specialists in Paris (UNESCO, 2000). The meeting suggested that the best medium (psychologically, sociologically and educationally) for teaching a child is his or her mother tongue. In this regard, the mother tongue can be a useful tool in contextualising the learning and the processes within a classroom. When students' mother tongue is used in the classroom as a medium of instruction, it will enhance their performance and progress academically (Cummins, 2000). The theory proposed by Cummins (Common Underlying Proficiency or CUP) for example suggests that knowledge of a concept in a native language promotes the transfer of that knowledge into a second language. In promoting knowledge transfer, a review of the literature suggests that there is interdependence between knowledge in a first language and learning in a second language (Bernhardt & Tedick, 2010; B. A. Brown & Ryoo, 2008; Dickie & McDonald, 2011; Gayle, 2000; Johnstone & Selepeng, 2001; A. M. Taufe'ulungaki, 2000). In the present study, it appeared that most of the students in CS3 were less competent in English than those in CS1 and CS2. Thus the use of the Samoan language by the teacher in CS3 enabled them to process information about chemistry and understood the concepts more quickly than when English was used. The teacher, Fono, "... chose to use Samoan to teach ... using our mother tongue to explain is the first point of contact with the students, in a way that is familiar to them" (Fono-CS₃TInt).

The data about the use of Samoan language in CS3 was used by the researcher to develop a model which shows how the students progressed in trying to make sense of chemistry through the following three phases: *Introduction*, *Exploration*, and *Performance* (see Figure 7.2). According to the students' explanations, as they move from one phase to the other, there is often some increasing understanding of the concepts.

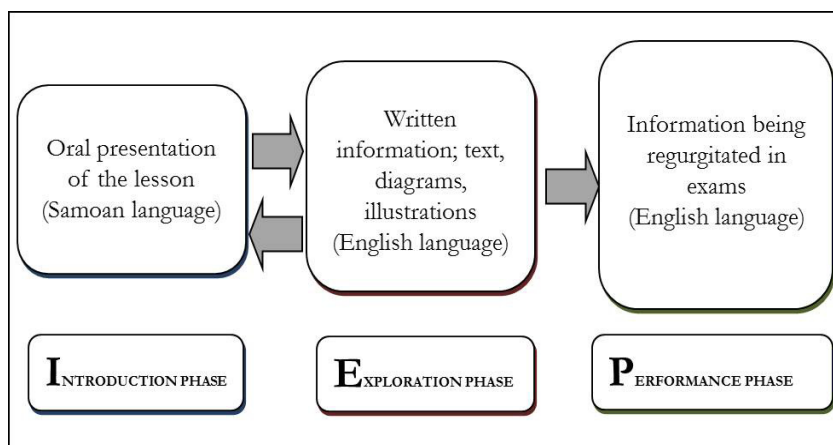


Figure 7. 2: IEP Model of students' learning of chemistry concepts in CS3

The *Introduction* phase, according to the data from CS3, is where the teacher introduces new chemistry concepts and presents the lesson using the Samoan language. Students are more likely to feel comfortable because the use of their first language enables them to absorb the material with confidence faster than when English is used. Additionally, information processing may take place in a shorter period of time compared to that taken to process information when the English language is used.

The second, *Exploration* phase is where students use the knowledge gained from the lesson presented to make sense of the large amount of text/notes that are written in English. The notes are the written representation of what was orally presented by the teacher. The second phase involves rearrangement of the ideas that were received orally in order to make sense of the written information and illustrations. The students talk to themselves in Samoan as they try to make sense of the notes and translate the English text in Samoan.

The arrows in the diagram (Figure 7.2) represent how the students tended to move between the first two phases as they tried to make sense of what was taught in class. Data from the classroom observations and interviews revealed that when the students were not sure of an idea, word, or scientific explanations (from the introduction phase) they asked their peers for clarification in Samoan.

The third phase, *Performance* highlights the goal of teaching and learning of chemistry found in this study was towards passing highly in the SSC exam where the teacher supplied the information. To the three teachers, achieving as highly in the SSC chemistry exam is considered important to students as well as parents, because they want their student/child to get credentials (SSC) with good results. Thus, it appears that the success for the teacher and for the school as a whole is demonstrated in student performance (results) on national exams such as SSC and the Pacific Senior School Certificate (PSSC in Year 13).

7.2.3 Samoan language in assessment

Even though the three case studies gave evidence that the use of English as the language of instruction had associated problems, the use of Samoan also posed some concerns which were rather more evident in CS3. The concern was that while the use of the Samoan language was important to gain understanding of chemistry in CS3, the students experienced difficulties during assessment because Samoan is not used in learning tasks, internal assessment, unit tests and the SSC chemistry exam. Under these conditions, the use of Samoan language to teach chemistry is considered a barrier by some of the students from CS3. This is because the official language of assessment is English and the Samoan language is not considered a language to be used. The data raises two issues. The first relates to the frequent use of the Samoan language in the teaching of Year 12 chemistry in CS3. The second concerns the use of Samoan language, Samoan education language policy and assessment.

The first issue relates to the discussion earlier, where the students in CS3 who were less competent in English than those in CS 1 and CS2 reported that the use of the Samoan language enabled them to process chemistry information more quickly than when English was used. While the students reported that the teachers' use of Samoan to explain chemistry concepts supported learning with understanding, especially when English

language proficiency was low, the use of English for assessment purposes presented a barrier for students to demonstrate their learning. This meant that there was a problem when they needed to explain things in English when it comes to assessment such as learning tasks, internal assessment, unit tests and SSC chemistry exam.

The second issue relates to language policy in Samoa education, which proposed bilingualism to “ensure development and maintenance of Samoan language whilst acquiring English with both languages developing high levels of proficiency”(Ministry of Education Sports and Culture, 2006b, p. 17). On the basis of this proposal the use of Samoan language as evident in CS3 may be viewed as essential in the teaching/learning processes. However, this is in tension with the Samoa Education policy which states that English is officially “... the language of access to educational opportunities and subsequent economic choices” (Ministry of Education Sports and Culture, 2006c, p. 34). Thus, English language is prescribed as the medium for instruction and assessment in all subject areas from Years 9-13 except the Samoan subject. These issues highlight the tension that may arise from the demands of understanding chemistry and demonstrating that knowledge and understanding in the context of two language policies. The most important goal by the teachers and students in this study is to achieve highly in the SSC exam.

Thus the use of English for assessment purposes presented a barrier to demonstrate the rural students’ learning, and therefore their achievement in terms of exam results may continue to fall. This is because these students (in CS3) are less competent in English than those in CS 1 and CS2. However, it would be interesting to find out the effects on SSC achievement if students could choose to use either Samoan or English in the examination or if they could get more support for their English language development.

7.3 Institutional factors

Institutional factors in this study are those relating to Ministry of Education, Sports and Culture (MESC) as well as those relating to the institutions or the school. Although they may be considered external and out of the control of teachers and the students, this study revealed that there were significant institutional influences on the ways the teaching/learning processes were conducted in the three case studies which influence students’ learning experiences and may impact on their achievements. The factor relating to

MESC concerned the lack of a science textbook tailored for the current Samoan Year 12 chemistry curriculum. The responsibility of the Ministry, through its Curriculum, Materials and Assessment Division (CMAD), is to prepare and provide textbooks for all schools in Samoa. However, the teachers in this study reported that there were not appropriate textbooks provided for the Year 12 chemistry curriculum and they had to search through a variety of textbooks found in their homes and school for their lesson preparation.

In relation to the school, the teachers and students across the three cases reported that there was a lack of sufficient science equipment and chemicals. In particular, each school is responsible for providing other teaching and learning resources, such as science laboratory facilities, equipment and chemicals that the school can purchase from the CMAD's science department. If monetary contributions are available from overseas' agents such as the New Zealand Agency for International Development (NZAID), Australian Agency for International Development (AusAID), Japan International Cooperation Agency (JICA) and China (Ministry of Education Sports and Culture, 2007), then the schools request to the ministry from which some of the resources may be purchased centrally and distributed to schools. The teachers and students in this study indicated that a lack of both textbooks and sufficient science equipment and chemicals were barriers to chemistry achievement.

7.3.1 Lack of science textbooks tailored for the Samoa Year 12 chemistry curriculum

International literature (for example: Heyneman, et al., 1981; Kahveci, 2009; Lemmer, Edwards, & Rapule, 2008) suggests that textbooks can provide an excellent and useful resource in the teaching and learning processes without usurping the position of the teacher to provide optimum guidance in their learning (Taber, 2011). Yet in this study the lack of textbooks tailored for Samoa's Year 12 chemistry curriculum is a concern to both teachers and the students. It is a concern to the teachers because they had to search for textbooks that provide descriptions and explanations, diagrams and illustrations of the scientific ideas that are required for this level. The three teachers in this study appeared to be using different individual chemistry textbooks depending on what they had collected over the years of teaching science subjects. Eileen stated in the interview that "I used old textbooks that I had collected during my university years" (Eileen-CS₂TIInt). In this example, the level of the English language used in these textbooks as well as the subject

content may not be able to be easily understood by the students and perhaps the teacher as well. She prepared copies of various pages and gave them to the students as she felt she had to provide students with notes about a specific topic, lesson or concepts.

In the interview with Fono, he stated that he often “invites the students to use the textbooks from my table”, yet he realised that the English “language [in these textbooks] is too hard for them to understand” (Fono-CS₃TInt). In addition, many of these textbooks explain a series of concepts and contain illustrations not relevant to the Year 12 chemistry curriculum. However, Fono wanted the students only to be exposed to the material necessary for the exam. Having a textbook tailored for the current curriculum would be able to expose students to the materials necessary for the exam.

Because of no textbook tailored for the current curriculum, the teachers tried to ensure that notes are prepared beforehand. In this regard, the three teachers reported in the interviews that they spent time searching, reproducing pages from textbooks in order to prepare notes for every lesson. Having a textbook tailored for the curriculum allows the teachers to spend more time on providing tasks to help students make sense of the concepts and designing laboratory experiments. Having an appropriate textbook which each student could have a copy of during the year should be offered alongside a professional development to provide workshops where they can work together to develop more useful learning activities than copying notes. Osborne and Collins (2001) suggested that copying notes is a feature of science teaching “which has little educational benefits” and students find dulls their enjoyment of science (p. 450).

Martin, Sexton, Franklin and Gerlovich (2009) describe the provision of textbooks as the most cost-effective way of improving student performance. This is even more so when textbooks are tailored to the country’s own curriculum and students are able to access the books for independent study (e.g., homework). Such relevant science textbooks are key sources of information for both teachers and students considering the curriculum and assessments (C. J. H. King, 2009). Evidence from this study shows that the three science teachers rely on science textbooks most of the time for scientific explanations, descriptions and illustrations of chemistry concepts, in preparing their notes.

Teachers and students in this study indicated that the lack of a science textbook tailored for the current Year 12 chemistry curriculum impacted on the teaching and learning processes. It did not stop the teachers and students from searching through other textbooks in order for the teachers to get the notes and for students to get some help in understanding the chemistry concepts. This suggests that the chemistry teaching occurred in the three case studies could be described as the product of textbook-centered teaching (Joel J. Mintzes, Marcum, Messerschmidt-Yates, & Mark, 2012; Stinner, 1992). In general, a textbook-centered science teaching culture rests on two presuppositions: that there is a specifiable scientific method that guarantees success, and that the expert is able to break down the content into teachable units that can be sequenced for the consumption of the learners (Joel J. Mintzes, et al., 2012). In this regard, learning is seen as a slow accumulation of knowledge through practice, where the learner is assumed to be a *tabula rasa* by simply ignoring their prior concepts (Russell & Martin, 2007). If science teachers learn their science from textbook-oriented classrooms, and they then teach from textbooks, then this largely emphasises memorisation of scientific facts (Edwards, 2004).

7.3.2 Lack of sufficient science resources to do experiments

Science resources for experiments in this section refers to science equipment ranging from general laboratory equipment (e.g., tripod and retort stands, model kits, thermometers, reagent and plastic dropping bottles), to glassware (e.g., distilling apparatus, burettes, pipettes, flasks and tubes), to electronic and electrical systems (e.g., electronic balances and power supplies). Additionally, this section also discusses the availability of organic and inorganic reagents/chemicals; acids, bases and indicators necessary for experiments at this senior secondary school level. The study found that all of the three case study classes were lacking sufficient science equipment and chemicals at the time of the investigation. According to both the teachers and students in this study this is a strong barrier to the teaching and learning of Year 12 chemistry.

The lack of sufficient science resources was cited by the teachers as the reason why no experiments were carried out across the three cases during the investigation. Yet, in the literature experiments are considered an important component of the science teaching and learning (Chin, 2006; Hofstein, 2004; Hofstein & Lunetta, 2004). Experiments allow students to learn with understanding and engage in a process of constructing knowledge by

doing science (Kang & Wallace, 2005; Kipnis & Hofstein, 2008; K. Tobin & Llana, 2010). In Samoa, questions about experimental procedures, observation, results and conclusion of experiments make up 10% of the questions in the SSC chemistry exam (Ministry of Education Sports and Culture, 2010). The data from the teachers' interviews showed that they think of experiments just as the literature describes (e.g., Chinn & Malhotra, 2002; Hofstein, et al., 2004; Shulman & Tamir, 1973). According to these studies, experiments can be used for a variety of different learning purposes that aim at:

- arousing and maintaining an interest and curiosity in science;
- developing creative thinking and problem-solving ability;
- promoting aspects of scientific thinking and the scientific method and process skills;
- developing conceptual understanding and ability; and,
- developing skills in experimental techniques; i.e., observation, handling apparatus, measuring.

While the teachers thought that carrying out experiments could be used in these ways the study showed that chemistry experiments were not in fact used in ways which could achieve these aims. The lack of laboratory experience in the three case study classes, may be an important factor that hinders Samoan (and Pacific Nations) science students moving onto tertiary education where there is a necessity for students to be able to carry out experiment within the laboratory (Soti & Mutch, 2011).

Despite being frustrated by the lack of sufficient science resources for experiments, the three teachers chose to describe the experiments so that the students were at least exposed to information about the way an experiment would normally be carried out. This included the details about the materials and apparatus to be used, the procedures for carrying out the experiment, and the results the students were to know for the exam. Illustrations of the experiment setups were also drawn up by the teacher for students to record in their note books.

Describing the experiment to the students seemed to occur so frequently, that teachers felt that such a way of teaching had become a normal routine. Such practices, somehow encouraged the students to become passive learners who saw their role as being there to listen and copy the facts about an experiment in order to memorise it. The information was

also presented for students to copy into their notebooks (something that some students did not enjoy doing; which is another barrier discussed in the section on classroom aspects). However, the teachers (e.g., Malaki and Fono) indicated that describing the experiment was the best way for them to expose the students to experiments when no sufficient science resources are available. Though not seen as ideal, it guaranteed that the students were exposed to the descriptions of the experiments before the SSC chemistry exam. Eileen however, postponed her class experiments until the arrival of the supply of the equipment and chemicals. According to Eileen, she had requested a supply of science resources in the year before and she was hoping that they would arrive before the exams.

The literature suggests that describing experiments is simply telling students what to do and what the teachers want the students to know. Such a way of teaching is not the optimal way to help students construct new knowledge (e.g., Eshleman, 2002; Lujan & DiCarlo, 2006; Schwartz & Bransford, 2009). Instead, the students' only option is to treat the presented information as facts to be memorised rather than as tools to help them think or do science. Under these conditions, the novices can easily think that they understand, when in reality they may have missed important distinctions (Schwartz & Bransford, 2009), knowledge, and skills about the experiment. One example taken from the interviews to demonstrate this phenomenon is where Malia (CS3 student) was not able to give a clearer explanation whether the gas collected in the diagram was saturated or unsaturated despite her knowledge of the experiment which had been described.

7.4 Classroom factors

Four classroom factors stood out across the three cases: the emphasis on lecturing as a pedagogy, using tasks to practise for exams, the role of peer interactions and the amount of information in a lesson.

7.4.1 Lecturing: A way to deliver exam related facts to students

The word lecturing was often used by Eileen (CS2) in the interview to describe the way she taught. She believed that such a way of teaching was important in order to get all the exam related facts to students so that they could pass the SSC chemistry exam. In this sense, she regarded her way of teaching as a support for students' achievements. The other two teachers did not mention the word lecturing, but classroom observations revealed that their

lessons' presentations were similar to Eileen's lesson presentations. This included the teachers spending most of the 50-minute session presenting information through explanations, descriptions and demonstrations of chemistry concepts from the board (in CS2 & CS3) or from the handouts (in CS1). In fact, this way of teaching was not specific to the chemistry teachers, but "all teachers here teach like that ... everyday" (Mary-CS₃S₃Int). In any one lesson, the three teachers included a huge amount of information because they considered this necessary to help students answer the questions in the SSC chemistry exam.

The observations of the lessons across the three case studies showed that the teachers' use of lecturing followed a very similar structure, which appeared to be about having control over the students' learning experience. Controlled lecture methods meet the needs of students who learn best in very structured content-centered settings (DiCarlo, 2009). This is because according to the three teachers, students become accustomed to the perception that what they are given in class is 'necessary for exams'. In this study it is what the teachers tells (verbal information) and gives (written information) to them in class that is important.

The students often mentioned in the interviews, that they are "there to learn what the teacher gives ... in order to pass the SSC chemistry exam" (Losi-CS₁S₁Int). In Samoa, parents place high expectations on attributes such as intelligence and students' achievement as judged by examination results. The realisation that their child has a low level of achievement can be a huge disappointment to parents and relatives (A. M Taufe'ulungaki, 2004). Such disappointment is indeed becoming more common in many families and parents are questioning the purpose of schooling for their children. However, passing exams does not necessarily mean they have strong conceptual understanding of chemistry. Eileen described in the interview that her role is to "teach them to pass the exam with high mark" in order to avoid being questioned by the parents if students do not pass. However, as the teachers focused their attention on imparting knowledge and presenting factual scientific information to students some of the students were experiencing difficulties.

Some students felt that it was difficult to cope with the way the information was presented and it was too much to absorb in any one lesson. Some students from CS1 and some from CS2 stated in the interviews that they had no problem with this style of teaching, as long as they get the information to help them pass the exam. However, the students from CS3

stated that the way in which the chemistry lessons were presented was long, boring, tiring and confusing, with too much to learn. These students became withdrawn from the lesson and engaged in activities which Nuthall (2012) described as the activities of their semi-private and private contexts in relation to classroom learning activities. For instance, the semi-private context was revealed when some of the students started disturbing others when they became withdrawn from the lesson. Sam (CS2) stated in the interview that he “talked to his friend ... had a bit of laugh” when he felt bored. Although in this example, peer interaction may not necessarily be about learning about the lesson or responding to what the teacher expected of them, but such behaviour was chosen by the students because they felt disengaged. In contrast, positive examples of semi-private contexts were revealed when students talked to peers about chemistry concepts. The private context is about what goes on inside the student’s head, which may influence the student’s choice of doing things apart from listening to the lesson. According to Joyce (CS2) she stated in the interview that because the lesson was too long and boring, she decided to read the notes from the previous chemistry lesson.

In this study, suggestive evidence shows that the lecture style teaching is accepted as unproblematic by more students from urban area schools (CS1 and CS2) than those from the rural area (CS3), though it was used across the three cases. Perhaps this is due to the fact that there are more above average students in urban schools in terms of ability and English language proficiency who are able to cope with such a style of teaching (Entwistle & Entwistle, 1992). These students have been selected from the primary schools around the country after Year 8 national examination. However, this style of teaching has been found to be a relatively ineffective pedagogical tool when it comes to promoting conceptual understanding (Knight & Wood, 2005). Instead, students are regurgitating the facts that were presented by the teachers in order to answer the questions in the SSC exam. However, while regurgitating facts may result in good marks in the exam the way it is currently structured doesn’t make anyone a scientist or able to apply chemistry to their real life experiences. According to Malaki, those who are able to memorise would be able to answer more questions and they are more likely to achieve higher in the exam.

7.4.2 Tasks to practise the skills necessary for exams

In this study, all three chemistry teachers frequently talked about the nature and the purposes of tasks to practise the skills necessary for exams. This was apparent in the lessons observed and in the interviews, and most of the students seemed to take this on board. Pre-exam practice tasks were identified by the teachers and most of the students in this study as supporting achievement in chemistry. The view of those who did not see doing such tasks as supporting their exam achievements is discussed later in this section.

The tasks found in all of the three case studies consisted of problems and questions similar to those that commonly appear in the SSC chemistry exam. Essentially, the tasks were intended so that students:

- become familiar with the style of questions in the exams
- know how to answer questions that they might find in the exam
- become proficient in answering questions by increasing their speed and accuracy
- become familiar with the terminologies (i.e., explain, justify, calculate) that are commonly used in exam questions, and
- gain confidence in reading and answering questions precisely.

Passing the SSC chemistry examination appeared to be the primary goal of teaching and learning that occurred in the three case studies. The teachers talked about it in class, and they often mentioned during the interviews that tasks used throughout the study were mainly geared towards passing the exam. To these teachers, their job is to help students pass the SSC chemistry exam, and therefore it was important to provide the necessary information and give exam-like questions to prepare students. In their view, practising answering exam-like questions makes perfect and the more students practice the better it gets; and some of the students realised this. However, passing the exam is not the goal in science education but to learn and make sense of science/chemistry concepts. Such learning and understanding help students to pass exams. Parents in Samoa often do not know what sort of education that their children need; they know what they want, but they don't know what's good; they know they want high exam results but they don't know what aspects of schooling are important for children to be successful later in life. In this study students tended to view exam practice tasks as a ways to pass the exam and achieve high scores, but not necessarily to help them learn chemistry.

While working on tasks appeared to be positively intended to promote exam results, some students from CS3 revealed that doing these tasks was not easy and there was too much work for them to do. The difficulties that these students experience included understanding the notes as well as the scientific concepts in relation to specific tasks. In these kinds of situations, Taber (2011) suggested optimum levels of instruction and teacher guidance to help monitor and direct students' learning while working on the tasks. Constructivists emphasise that each learner needs time, space and suitable experience to support the learning process, but when only minimal guidance is provided during learning it is unlikely to lead to the desired outcomes. Minimal guidance was evident across the three cases, where the teachers did not go around the room helping individual students.

7.4.3 The amount of information in any one lesson

This section refers to the chemistry content presented to the students in any one lesson. Data from the students' interviews and observations revealed that every lesson is packed with a great deal of verbal and textual information, diagrams, questions problems and tasks to complete. In this study, the teachers do not think that the amount of content they get through in each class is enough while students say it is too much.

Teachers felt that it was important to present all that is required in the curriculum. One of the reasons for teachers to give a great deal of information is to help students when preparing for the SSC exam. In addition to this, the teachers described how the current Year 12 chemistry curriculum is huge and must be completed before the SSC chemistry examination at the end of the year. However, too much content has been found to often lead to curricula characterised by isolated facts detached from their scientific origins and containing low levels of orientation towards relevant issues taken from students' everyday life or for societal concerns (Hofstein & Mamlok-Naaman, 2011). As a result, pupils often fail to make connections between the different facts and concepts presented and their practical applications, thereby missing the 'big picture' of science and never developing confidence in its relevance. According to Lujan and DiCarlo (2006) "there is too much teaching and not enough learning" in our science classrooms today (p. 17).

The students reported that too much information is a barrier, because they felt that there was too much 'teaching' but very little time for 'thinking', and they were not always able to understand everything. For instance, Tamatoa stated that there is too much information, yet he could not relate or find relationships between the chemistry ideas. Because of too much information being presented, the students were unlikely to make connections to, and between, the ideas in any one lesson. The students seemed to take a long time to process and come to some understanding of what the teacher was talking about. Sweller Ayres and Kalyuga (2011) referred to this as cognitive overload where the learner is not able to retain content and has to re-read material several times in order to retrieve or understand it. Without connecting to the students' prior knowledge in order to build new knowledge, information will seem new or unrelated, which may lead to attentional shifts and distractions (Roda & Thomas, 2006). Furthermore, the students will find it difficult to apply scientific ideas to their lives, which may contribute to the reasons why some students do not learn what the teacher is trying to teach in class.

According to Johnstone and Selepeng (2001), learners need cognitive space to hold newly input material and process it. If there is too much information there is little room left for processing and, conversely, if there is considerable processing to do, there is little room for taking in a lot of new information while this occurs. Learning material couched in complex, unfamiliar language requires a lot of room in the working space to transform it into an understandable form. In this context there is the added-fact that more transformation or translation stages may be required to simplify the material and make it understandable.

One other common factor that emerges from the three sections above (7.4.1, 7.4.2, 7.4.3) was that the teachers believed that a particular kind of transmission teaching was necessary to enable students to pass the SSC exam. As such, the teachers lectured large amounts of information which students had to repeat for the SSC exam. Unless the SSC exam assesses conceptual understanding as described in the curriculum, the teachers are likely to continue to practice 'transmission' approach to teaching where students copy and memorise for exams.

International literature, the Samoan science curriculum, and the government of Samoa, all emphasise making scientific concepts more meaningful and relevant. Teachers, therefore, need to consider the intention of the curriculum. They also need to understand that a focus on conceptual understanding need not be at the expense of achievement. Once students gain conceptual understanding they are more likely to perform well in exams. At the same time assessment need to be reviewed so that it aligns with the principles set out in the curriculum and in fact encourages a deeper understanding and relationship to the local context.

7.4.4 Peer interactions

Social constructivists emphasise the notion that students' interactions with peers/groups or with adults help to co-construct knowledge of a specific concept or subject. According to social constructivists the key is to create social interactions that facilitate achievement beyond individual capacity (Mercer, 2010; Mortimer & Scott, 2003; Vygotsky, 1978). Furthermore, Rowe (2004) argued that these interactions allow the students to come to or achieve greater, more advanced, or more complex meaning-making through talking with others in a dialogue format, especially with others with different experiences or expertise. In this study, peer interactions were commonly used by the students across the three case studies and were considered by them as very helpful and supportive of learning.

While the teachers did not plan for or encourage peer interactions, the students chose to turn to their peers for various reasons such as referring to their peers for clarification when they did not hear what the teacher said, did not understand a chemistry idea, or wanted to find out more about a chemistry idea. To them it was easier to ask other students who may know the right answer and may be able to explain it in a way that is easily understood by other students than asking the teacher. Some of the students reported that they learned a great deal from one another and they would continue to ask each other. There is ample evidence in the literature which states that peer instruction is a cooperative learning technique that promotes critical thinking, problem solving, and decision-making skills (for example, Cortright, Collins, & DiCarlo, 2005; Schibeci, 1989). As well it increases conceptual understanding, resulting in improved students' performance (Smith, et al., 2011). More importantly in peer interactions is the role of the teacher to scaffold and encourage the students learning through guided instructions (Taber, 2011) rather than

discouraging them to talk to each other. However, such teacher guidance and encouragement of peer interaction about chemistry did not occur in any of the three cases in this study.

Research by Wendt (2006) and O'Meara (1990) revealed that many Samoans prefer to work with peers because it is part of their social upbringing, such as cooking or in their day-to-day routines at home. While working in these routines with peers or in groups the members within the group (peers) are expected by the leader/adult/chief/parent to master the material and help each other learn it or solve the problem. As such, peer or working with others can be viewed as part of the *fa'a-Samoa*, where people tend to work together to accomplish a goal. In these kinds of situations the concept of respect and *va-fealoa'i* are encouraged and monitored by the leader/adult/parent as they work together. In addition, each member participates according to the key components of *fa'a-Samoa*. However, the data revealed that when the students in CS2 started talking to each other the teacher immediately called "*ana le pisa*" (stop the noise) in attempts to make the classroom as quiet as possible. The teachers reported in the interviews that they believed that the students often talked in class among themselves about matters not related to the topic. The teachers therefore thought it was important to intervene and get their attention focused on what the lesson was about. Preventing peer interactions and collaboration may be viewed as a barrier because it disallowed the students from interacting and learning with each other about chemistry, and also, it discouraged students from implementing culturally appropriate pedagogies inside the classroom.

7.5 Chapter summary

In this chapter, the findings exploring to the factors that influenced students' achievements in chemistry have been discussed. The findings from individual case analysis and cross-case analysis have been utilised throughout the discussion and are summarised in Table 7.2 below. These factors were found in the teachers' and students' perspectives on teaching and learning of chemistry as well as the nature of the classroom learning environment. The supports and barriers reflected viewpoints relating to the Samoan culture, the institution and the classroom.

In the first section about the Samoan cultural viewpoints, the discussion on *fa'a-Samoa* shows a difference of opinion between the teachers and students. In particular, the key cultural values held by the students in this study were identified as barriers by the teachers. However, these cultural values are evident in the science classroom, because they are part of their life. So instead of trying to change, or even work against them, perhaps the teachers need to be flexible and adopt ways to encourage active participation and questioning, and at the same time, sustain cultural values.

Despite English being the official language of delivery, the use of the Samoan language is a vital cultural tool when both information sharing and questioning are used to explore ideas in the Samoan classroom. The study identified the significance of the use of the Samoan language as the mode of delivery, particularly in circumstances where the English language proficiency of students was considered low (CS3). The use of the Samoan language allows more working memory space to process chemistry concepts. Essentially, the students' *va'ai* and *fa'alogo*, *mafaufau* and *fa'aaogā* and eventually the material they are exposed inside the classroom become more meaningful to them to be able to *tautala* and *fa'aילוa* in a range of situations in their lives.

The Samoan language was revealed (in CS3) to be a useful language in *introducing* scientific ideas to the students in order to be able to link this knowledge to the information presented in class by *exploring* until they fully understand. The process may take time as the students move between the introductory to the exploratory phases as they try to understand the chemistry ideas and English words by using their knowledge of the concepts received in the Samoan language. However, despite these significant functions, when it comes to assessment, the use of Samoan language in chemistry becomes a barrier, as English is the only language of assessment and it is the official “language of access to educational opportunities and subsequent economic choices” (Ministry of Education Sports and Culture, 2006c, p. 34). In addition, it is a vehicle for communication and administration in schools and the workforce in Samoa. Thus, the Samoan language may help them to understand scientific concepts but unless they have the opportunity to transfer that understanding into English and maybe to discuss in English and make those links, then it is not surprising they are still not doing very well in the exams. This is because

there is no connection between what they've been talking about in Samoan and what they are trying to either read or write in English.

Factors relating to the institution (MESC) and the school are identified as barriers by both students and teachers. Lack of science textbooks, equipment and chemicals in the three schools meant that the teaching and learning were limited in terms of constructing knowledge by doing science experiments. Instead the teachers spent more time on explaining and describing, which the students did not find appealing. Students became more adapted to becoming passive listeners and receivers rather than the active participants suggested as desirable by science researchers (e.g., Chin, 2006; Hofstein, 2004; Hofstein & Lunetta, 2004).

The final section of the discussion reported aspects relating to three case study classrooms which included teachers' and students' views about: lecturing style of teaching, structural tasks, peer interactions and information presented in class. The discussion outlines some opposing views of teachers and some students upon these classroom aspects. For instance, the teachers presented their lessons in a lecture style format, which they viewed as important for the transfer of the information necessary for students to pass the SSC chemistry exam. With such focus, some students mainly, from urban schools (CS1 and CS2), found it supportive as they are presented with the exact information for the exam. However, it promotes memorisation and regurgitation of scientific facts. Other students who had difficulties with this teaching approach, engaged themselves with other things (i.e., looked at notes from previous lesson, started copying notes from board, talked to peers) while the teacher presented the lessons.

Another strategy seen across the three case study classrooms was the provision of tasks for students to do either in class or at home. The design and purposes of these tasks emphasised that students complete them as practice because they consisted of problems and questions similar to those that commonly appear in the SSC chemistry exam. To the teachers, the provision of this kind of practice was particularly useful for students as they prepare for the exam, and encouraged individual construction of knowledge. However, some students found the tasks difficult to understand and therefore difficult to complete, particularly as every task was designed to be carried out individual. This is a problem

because students wanted to ask their peers for clarification as they found asking the teacher challenging and disrespectful.

The study revealed that the teachers believed that their role was to get students through the SSC exam. This led to a huge amount of information being presented to the students which they had to memorise and repeat in the exam. However, the Samoa science curriculum as well as international literature on science education have shifted the emphasis to making scientific concepts more meaningful and relevant. At the same time assessment needs to be aligned with the intention of the current science curriculum.

According to social constructivists, the students' interactions with peers/groups or adults co-construct knowledge of a specific concept, a subject or a phenomenon. In this study, the teachers did not allow peer interactions. However, the literature suggests that learning is enhanced through social interactions amongst students that facilitate achievement beyond individual capacity and be able to help one another (Mercer, 2010; Mortimer & Scott, 2003; Vygotsky, 1978). In Samoa, people prefer to work with others because it is part of their social upbringing, such as in meetings (*fono*), cooking, or in their day-to-day routines (O'Meara, 1990; Wendt, 2006). While working in these routines with peers or in groups the members within the group (peers) are expected by the leader/adult/chief/parent to master the material and help each other learn it or solve the problem. As such, peer or working with others can be viewed as part of the *fa'a-Samoa*, where people of the same level tend to work together to accomplish a goal either in English or Samoan languages.

The three teachers in study worked to ensure that students were given notes to read and copy as well as tasks to do. This is, in fact, part of their perceived teaching roles to provide students with information/notes to help them pass the exam. As such, huge amount of notes were prepared for any one lesson. While teachers thought that giving a lot of notes/information was useful, some of the students disagreed because they were presented with so much, not only in chemistry but also in other subjects. International researchers have also argued that there is too much teaching verbal and textual information in our classrooms today and not enough learning where students can connect what they learn in the classroom to their world (for example; Lujan & DiCarlo, 2006).

In the next chapter, research conclusions, contribution to knowledge and implication for practice are presented. Future research ideas are also suggested.

Chapter 8 Conclusions and Implications

8.1 Introduction

This chapter presents the conclusion of this study that focused on exploring the supports for and barriers to students' achievements in Year 12 chemistry in Samoa. The study involved three government co-educational secondary schools: two from urban areas and one from a rural area in Upolu, the main island of Samoa. One chemistry classroom from each of the three schools represents a case and they are identified as Case Studies 1, 2 and 3. The information from the participants' interviews, classroom observations and samples of students' work were analysed and a summary were identified and have been discussed in Chapters 4, 5 and 6. Analysis of both common and distinctive themes across the three case studies revealed the ways in which factors that relate to Samoan cultural values, the institution (including MESC and individual schools) and the classroom could act as barriers or supports to students' chemistry achievement (see Table 8.1). These key themes were appropriate to help answer the two research questions that guided the study:

1. What factors support achievement in Year 12 chemistry classrooms in Samoa?
2. What is the nature of barriers to achievement in Year 12 chemistry classrooms in Samoa?

In this chapter, the research conclusions are presented followed by the contribution to knowledge. Then, implications of this study in terms of theory, research and practices are offered to assist teachers and policy-makers in improving teaching and learning within Year 12 chemistry in Samoa. Areas for future research are also explored and final thoughts from the author are presented.

8.2 Research conclusions

The key ideas (see Table 8.1) indicate the factors that influence students' achievements. In particular, some of these factors were revealed as supports and some as barriers, with a few where the teachers' and students' perspectives contradict one another and were therefore identified as both support and barrier. An important aspect in the study emphasises the learner, and the fact that what is learnt cannot be separated from how it is learned and used and the activity in which knowledge is developed. In this sense, the nature of learning emphasises the situatedness of the learner in specific environments (Lave, 1996).

According to Saddler (2009) these "environments or contexts are formed, in part, by the

learners and other participants along with available ideas, tools and physical resources”. Furthermore “as individuals participate in environments and engage with the communities that form these environments, they begin learning” (p. 2). In the next three sections, the conclusions about what the research participants suggested as supports and barriers to learning Year 12 chemistry in Samoa are outlined.

Table 8. 1: Summary of support and barriers to achievements in Year 12 chemistry in Samoa

	<i>Teachers' perceptions</i>	<i>Students' perceptions</i>
<p><i>Samoa cultural viewpoints</i></p> <ul style="list-style-type: none"> • Fa'a-Samoa • Samoan language to teach chemistry to students with low English language proficiency • Samoan language in assessment 	<ul style="list-style-type: none"> • Barrier (CS1) • Support (CS3) 	<ul style="list-style-type: none"> • Support (CS3) • Support/ barrier (CS3) • Barrier (CS3)
<p><i>Institutional factors</i></p> <ul style="list-style-type: none"> • Lack of sufficient science resources • Lack of science textbooks tailored for the Samoa Year 12 chemistry curriculum 	<ul style="list-style-type: none"> • Barrier (CS1, CS2, CS3) • Barrier (CS1, CS2, CS3) 	<ul style="list-style-type: none"> • Barrier (CS1, CS2, CS3) • Barrier (CS1, CS2, CS3)
<p><i>Classroom factors</i></p> <ul style="list-style-type: none"> • Lecturing to deliver exam related facts to students • Tasks to practice skills necessary for exams • Peer interactions • The amount of information in any one lesson. 	<ul style="list-style-type: none"> • Support (CS2) • Support (CS1, CS2, CS3) • Barrier (CS1, CS2) • Support (CS1, CS2, CS3) 	<ul style="list-style-type: none"> • Barrier (CS1, CS2, CS3) • Support/barrier (CS1, CS2, CS3) • Support (CS1, CS2, CS3) • Barrier (CS1, CS2, CS3)

8.2.1 Samoan cultural viewpoints

The factors relating to the Samoan culture discussed in the previous chapters include a few key components of the *fa'a-Samoa* (Samoan way of life) and the use of Samoan language to teach chemistry. The components of the *fa'a-Samoa* were evident across the three case studies where the students showed *fa'aaloalo* (politeness, mutual respect and social collaboration between people), and observed the *vā fealoa'i* (the sacred space between individuals) with their teachers. In a sense, the *fa'a-Samoa* in the three cases can best be described as a more comfortable arrangement for these students as they listen and copy information about chemistry ideas to help them pass the exam. Asking questions was considered by most students as being about challenging authority, as well as being disrespectful and rude in a Samoan context. Thomas (2006) reported similar results from a study in Hong Kong which suggests that the concept of filial piety in cultures prevents students from challenging the authority figure in the classroom. In this sense, the expression of respect by students acknowledges the teachers for the value they bring to a situation (Sennett, 2003, p. 260). It also promotes obedience to teachers (or elders), (Gow, et al., 1996; McManus, et al., 2003). This kind of behaviour is well accepted and acknowledged in the Samoan community. A child acting according to these cultural beliefs is often praised as a good child in the eyes of Samoans. Despite of being loyal to the teachers (or elders) the interview revealed a tension where some of the student participants said they would have liked to ask the teacher questions and seek further clarification when they didn't understand.

In contrast to the viewpoints of the students about the *fa'a-Samoa*, the study also found that it had a great influence on the processes and activities that took place in the classroom and was a concern to the teachers in which they wanted the students to ask questions. But the teachers realised that the students are taught at home to respect adults. Part of this respect is not to challenge adults at home or in a classroom context, and not to direct questions to the teachers, but to *fa'alogo* (listen) and *va'ai* (observe), *mafau'au* (think) and *fa'aaogā* (make sense), and be able to *tantala* (speak) and *fa'a'ailoa* (demonstrate) what you have learned in a more culturally appropriate way, or in writing. These important processes are significant as children develop. However, the teachers revealed that the students only seemed to 'listen' and 'observe' but show no evidence of 'thinking' and trying to 'make sense' of what is being talked about. Also, they do not ask questions, speak out or tell the teacher what they

have learned, except responding by completing a written task. Questioning lies at the heart of scientific inquiry and meaningful learning (Chin & Brown, 2002; Chin & Osborne, 2008). It is one of the “thinking processing skills which is structurally embedded in the thinking operation of critical thinking, creative thinking, and problem solving” (Cuccio-Schirripa & Steiner, 2000, p. 210) and focuses the attention of students on content, main ideas, and checking if content is understood. The analysis of the findings from the students’ interviews showed that the lecture-based teaching style and the sheer amount of information presented also precluded the thinking, sense making and questioning the teachers said they wanted.

Although there is a requirement that English be used as the official language of instruction in Samoan secondary schools, the use of the Samoan language was identified in CS3 as a support and Fono believed that it was the essential medium for the teaching and learning of chemistry. This is because Fono was concerned about the low English language proficiency of his chemistry students. The students (CS3) found the use of the Samoan language helpful in terms of gaining conceptual understanding and familiarities with scientific ideas as opposed to the use of the English language. Basically, they were able to process the information faster than when English was used. This concept is illustrated further by Johnstone and Selepeng (2001) who emphasised the influence of the use of native language towards working memory space. In this regard, the students’ knowledge of chemistry concepts gained from the *introduction phase* is used in the *exploration phase* (explore the notes and diagrams presented in the English language) and they are more likely to do well when the *performance* is assessed. Using the Samoan language, these processes reflect important components relating to learning in our *fa’a-Samoa* which define the Samoan way of life. The study shows that these students (CS3) talked about and shared their understanding of the chemistry concepts and processes being studied with other students using the Samoan language.

Language plays an important role in the teaching and learning of science subjects. In CS3 Samoan language was found by the teacher and students to be helpful for gaining conceptual understanding. However, the same students (from CS3) made a claim that it is a barrier during assessment where English is the only language used to answer questions in tasks, unit tests, internal assessments and the SSC chemistry exam. The students who were

taught in the Samoan language found it problematic when they needed to explain things in English in the assessment tasks. In line with Johnstone and Selepeng's (2001) study, it was anticipated that when the "test was done in an unfamiliar language, space would be taken up with translation ... and so the available working space would diminish compared with the performance in a more familiar language, which needed no translation" (p. 24).

On the basis of the responses from the students in CS3, there is a possibility that they may not be able to achieve highly in the SSC chemistry exam and other science subjects (that also using the English language). In this regard, the students believed that even if they understood the concepts in Samoan it was still difficult because they could not express those ideas in English, particularly in the assessment tasks. Additionally, they may not be able to continue to stay in science education or may choose to leave school and stay at home because they do not have credentials to look for jobs. They cannot continue to Year 13 because the results from the SSC (in Year 12), determine entry into Year 13. Yet, most of these students were able to demonstrate their understanding of scientific ideas using the Samoan language when they were asked during the interviews. This finding suggests that the MESC should look into ways to accommodate these kinds of students who are able to understand and express scientific ideas using their own language in terms of assessment and exams. This may give them the opportunity to do well in exams. It is also consistent with the Samoa science curriculum which focuses on the achievement of scientific understanding but not only on exam results (Ministry of Education Sports and Culture, 2004).

8.2.2 Institutional factors

Factors identified in this study as institutional barriers or supports are those relating to the MESC, as well as the schools involved in this study. Factors such as subject textbooks are the responsibility of MESC. This means MESC prepares and supplies textbooks to schools. As for each school, they are responsible to purchase science equipment and materials required for teaching all subjects. The study revealed that across the three cases the lack of textbooks tailored for the current Year 12 chemistry curriculum and of sufficient equipment and chemicals for science experiments were identified as barriers by the research participants. The teachers seemed unhappy about the lack of textbooks, because they had to search through a variety of texts to find simple and relevant descriptions to the

chemistry concepts required in the current SSC chemistry curriculum, before each lesson. Although the teachers and some of the students revealed that an overseas textbook was supplied by MESCC, they found it problematic as the level of some of the materials in the text were not suitable for Year 12.

Lack of sufficient science equipment and chemicals for doing experiments negatively influenced the ways in which the teaching and learning of chemistry occurred in the three case studies. In terms of teaching, there are concepts that require laboratory experiments in order to understand them (for example, bromine water to determine unsaturated hydrocarbons as students from CS1 and CS3 mentioned). However, because there was a lack of sufficient science resources specific for this experiment the teachers did not do it. Instead, they described all that is required (apparatus and procedures) in the experiment, including the expected outcome, with illustrations for students to know for the exam. Once again, the teachers continue to use a lecture-style of teaching to present laboratory experiments.

Describing experiments to the students appeared to be a common practice. It was not only during the course of this study, but the students reported that they had not done any experiments since the start of the year. Evidence from the international literature suggests that conducting experiments are considered important components of science teaching/learning (Chin, 2006; Hofstein, 2004; Hofstein & Lunetta, 2004). It allows students to learn with understanding and engage in a process of constructing knowledge by doing science (Kang & Wallace, 2005; Kipnis & Hofstein, 2008; K. Tobin & Llana, 2010). In essence, the students were told of the conclusion rather than figuring out the conclusion themselves. Basically, there was evidence of a high level of pure rote learning across the three case studies. The students were given the actual piece of information they needed about the results that should have occurred in order to answer the examination questions.

The impact of having no experiment to carry out is that the students will miss out on various scientific skills they could have achieved from participating in laboratory experiments (e.g., Chinn & Malhotra, 2002; Hofstein, et al., 2004; Shulman & Tamir, 1973). “A child best learns to swim by getting into water; likewise, a child best learns science by doing science” (Rillero, 1994, p. 1). Doing science, as opposed to simply hearing or reading

about it, engages students and allows them to test their own ideas and build their own understanding (Ewers, 2001). Therefore, it is difficult to imagine an effective science-teaching programme without opportunities to do science experiments.

8.2.3 Classroom factors

Specific to the classroom teaching and learning experiences, the study revealed four factors that the participants identified as influential to students' achievements. The first factor highlighted the teachers' goal to deliver all the exam-related facts to students before the exam (at the end of the year). To do this, they chose a lecturing-style of teaching. As the MESC emphasised achievement in terms of examination results (see also see Fraser & Chionh, 2009), the pressure of getting good results in the exam impacted on classroom instructions and learning environments. Basically, the students were encouraged to memorise, recall and paraphrase scientific facts in preparation for the exam, but it is short-term knowledge (Nieswandt, 2007). The literature describes this type of teaching as a traditional teacher-centered method using didactic presentation of a static body of facts (B. A. Crawford, 2007; DiCarlo, 2009; Polman & Pea, 2001; Southerland, et al., 2003). If students are not learning in a way that would be beneficial to them as scientists while in Year 12, it is possible that those who may go on to take chemistry in Year 13 and tertiary levels may find it more difficult to learn, understand and apply. This certainly may impact on the ability to achieve Samoa's vision for its people to achieve a better quality of life (Ministry of Education Sports and Culture, 2006c).

International science educators have, however, tried to shift the focus of teaching and learning of science from teacher-centered to student-centered instruction (i.e. National Research Council, 2007; Treagust, 2007). The primary reason is that teacher-centered instructional strategies focus on the presentation of a body of facts (B. A. Crawford, 2007; Polman & Pea, 2001; Southerland, et al., 2003), while student-centered instructional strategies emphasise critical thinking and problem-solving skills (McNeill & Pimentel, 2010; Treagust, 2007). In a more student-focused classroom, active learning methods are used where the students become actively involved to help each other become meaningful learners who can effectively construct their own knowledge in their mind. Such a viewpoint of constructivism has become the dominant paradigm in science teaching and learning (K. Tobin & Llana, 2010). While individual student engages in knowledge construction and

making sense of the scientific concepts from his or her own experience (individual constructivism), they also make meaning through dialogic process involving persons-in-conversation (T. Crawford, 2005). The successful development of knowledge constructions, however, depends on the teachers' effective guidance (an optimum level of instruction) to enable students to engage and develop conceptual understanding (Taber, 2011).

The second classroom factor describes the perceived importance of the tasks that teachers assigned for students to practise the skills necessary for the exam. The tasks that were implemented during the time of this study included written questions, problems and diagrams similar to the way they appear in the SSC chemistry exam. On various occasions, sections from past SSC chemistry exam papers that were related to the concepts taught in a lesson were used as classroom tasks or homework. Essentially, the tasks were intended so that students would:

- become familiar with the style of questions in the exams
- become proficient in answering questions by increasing their speed and by providing correct answers
- become familiar with the terminology (such as explain, justify, calculate) that are commonly used in exam questions, and
- gain confidence in reading and answering questions precisely English.

As the focus on passing exams (like SSC chemistry) became more evident in this study, some students who had English language difficulties became more keen about re-doing the tasks than reading the notes when preparing for a test or the SSC chemistry exam, because they found it a lot easier to read and remember the questions and the correct answers that they provided, than reading the notes. Such way of trying to memorise the questions and answers promotes rote learning where very little is stored permanently in memory since what is learned by rote is easily forgotten (Johnstone & Selepeng, 2001). Indeed, the classroom observations revealed that some of the students forget what was taught in the previous lesson when they were asked about chemistry ideas. This is because they did not understand it, yet they are asked to explain, describe or find solutions to some given problems. The focus on rote learning is consistent with the view of learning as knowledge acquisition in which people experience information, how it is stored in the brain, and how

it can be recalled for later use (Richard E. Mayer, 2002; Sfard, 1998). Thus, learning in this sense may be perceived as the process of absorbing and storing information in memory, the success of which is often gauged by how well the information can later be retrieved from memory (Richard E. Mayer, 2002).

The third factor describes students' preference for peer interactions in order to understand chemistry concepts. Evidence from this study showed that the students experienced difficulties while they were: listening to the teachers' presentations; reading or copying the notes; or working on a task. However, the students chose not to ask the teachers, because they believed that questioning is a challenge and it is a disrespectful practice in the Samoan culture and context. Therefore they preferred to turn to their peers for help. Since students realised that the teachers did not like them talking to their peers, they talked very softly and only when the teacher was not looking. According to the teachers, the students often talked about things other than the lesson and therefore it was better to exercise silence in the classroom so that everyone could hear what the lesson was about. An important aspect of a constructivist view of learning found in this study, is that learning is shaped by social interaction when they seek clarification of ideas from their peers (Lave, 1996). Data from the interviews showed that the students asked their peers for clarification of ideas from the lesson or from the notes.

Note copying was considered important by the teachers in this. Further illustrations and descriptions were provided during the lesson presentation to explain the notes. The study found that whatever the teacher wrote on the board during the chemistry lesson, the students tried to copy into their notebooks, some of which was incomplete because the teacher erased the board too soon. According to the teachers, it was important to give lots of notes and examples (information) for students' revisions because there was no textbook that they could refer to, especially several months after a topic is presented.

As the teachers attempted to cover the content of the curriculum the students tended to rote learn scientific concepts without the opportunity to apply their knowledge to solve novel problems. "The packed curriculum leaves little time for students to acquire a deep understanding of the subject or to develop life-long learning skills such critical thinking and problem solving" (Lujan & DiCarlo, 2006, p. 17). Therefore, the students repeat what they

believe the teacher wants to hear. In this setting, students forget much of the information they learn and are unable to use resources to find, evaluate and apply information to solve novel problems. Learning, however, is not about committing a set of facts to memory as it seems to be the situation in the three case studies but to develop an interest and love for lifelong learning. One way to achieve this goal is to reduce the use of the passive lecture format. Teachers need to motivate and encourage students to become engaged in learning activities in and out of the classrooms. This is critical because unless students are motivated our efforts are pointless. The study showed that using a lecture-based teaching style was not motivating students to learn for understanding but regurgitating ideas in order to answer exam questions.

8.3 Contribution to knowledge

The findings of this exploratory study suggest that some of the factors that influence students' achievements in Year 12 chemistry are similar to those identified in western literature. There are also factors that are unique to the Samoan context because of its culture, the ways in which things are done, and how teachers, students and parents perceive achievements in education. The curricula, teaching and learning methods, languages of instruction, assessment and evaluation methods and organisational cultures of schooling in Samoa and the Pacific continue in hegemonic forms, usually closely resembling those of their former colonial 'masters' (Puamau, 2005). Such curricula and methods became part of Samoa's culture and day-to-day practice where knowledge is dispensed by an adult, a chief, church pastor, teacher or the father while the children listen and obey all they have been presented with. The findings of this study suggest that there is a great need to appreciate the cultural context of learning and the learners in addition to the curriculum and the education policy. It is clear that the main focus of the teachers in this study was to prepare students for the SSC chemistry exam and at the same time ensure full coverage of the Year 12 chemistry curriculum before the exam.

There is also a need to teach students to learn and understand science/chemistry in a way that would be beneficial to them as scientists (Nieswandt, 2007). Furthermore, Nieswandt described that such "understanding goes beyond rote memorization towards the ability to explain everyday phenomena with current scientific knowledge" (2007, p. 908). As most of these students may go back into their homes and villages there is a possibility that they can

contribute such knowledge to the development of their communities. In addition their scientific knowledge may be able to help decision makers when dealing with science related issues.

The IEP Model of students learning of chemistry developed in this study demonstrates how the students progressed in trying to understand the chemistry concepts through three phases: *Introduction*, *Exploration*, and *Performance* (See figure 8.1). These are discussed in detail in Chapter 7.

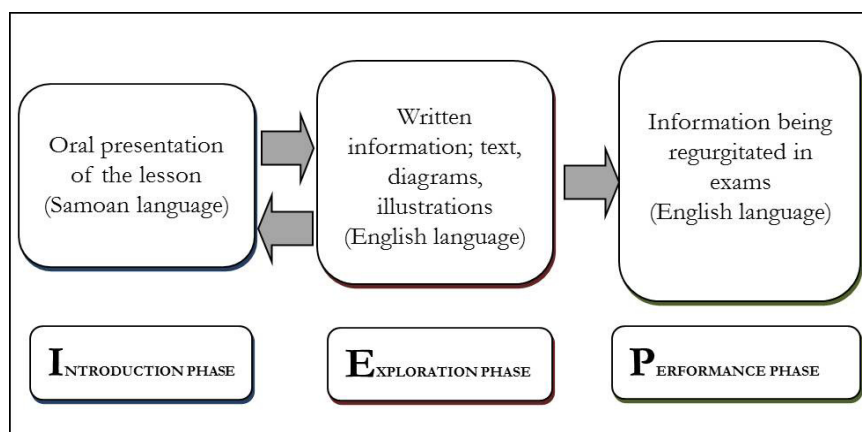


Figure 8. 1: IEP Model of students' learning of chemistry concepts in CS3

The model was developed from the use of Samoan language in CS3 to teach chemistry. It describes that once the students learn something in the introduction phase they use such knowledge to explore (exploration phase) and make sense of the written notes. Such knowledge of the information will be regurgitated in the exams in the performance phase. Essentially the goal of teaching and learning of chemistry found in this study was basically on the students' performance in the SSC exam. In this regard achieving as highly in the SSC chemistry exam is considered important to students as well as parents, because they want their student/child to get credentials (SSC) with good results. Thus, it appears that the success for the teacher and for the school as a whole is demonstrated in student performance (results) on national exams such as SSC and the Pacific Senior School Certificate (PSSC in Year 13). If the students do not grasp the ideas in the introduction

phase, it is very unlikely for the students to reach the third phase, hence the reverse arrows between the first and second phases.

The next two sections discuss some of the areas in which this study contributes to knowledge which raises some implications for practice. This is followed by a discussion of the limitations of this study.

8.3.1 Factors that support students' achievement

In this study the factors that the teachers identified as support highlighted their goal of teaching Year 12 chemistry. Basically, their goal was to deliver all the exam-related facts to students to be examined later. The teachers saw their main task as one of transmitting a body of scientific knowledge in the form of factual information, and giving practice tasks to the students to help them pass the exam. Across the three case studies, lectured-based teaching style was used by the teachers to deliver all exam-related facts to students. To these teachers, achieving as highly in the SSC chemistry exam is considered important, students as well as parents, because they want their student/child to get credentials (SSC) with good results. It appears that success for the teacher and for the school as a whole is demonstrated in student performance (results) on national exams such as SSC and the Pacific Senior School Certificate (PSSC in Year 13). However, this may raise questions such as whether this should be the focus of science education in Samoa because it seems that only those students (from urban schools) who are able to cope with the language of instruction and the teaching and learning strategies, and are capable of memorising scientific facts, are likely to be able to do well in a system like the one that operated in the three cases. If there are to be many science students entering tertiary education, the current operation of schooling in secondary schools may not be able to prepare students for future challenges. The MESC may therefore be experiencing difficulties in order to achieve its mission of trying to ensure an efficient supply of qualified students with professional scientific knowledge to take advantage of the technical and market-oriented economy that Samoa is facing today (Ministry of Education Sports and Culture, 2006c).

Some of the students in this study also identified support factors that suggest teaching and learning strategies that are familiar and comfortable for them. Such strategies are brought into the school by the students from their own personal, social and cultural situations. For

instance, the students reported that they asked their peers for clarification because asking the teacher was considered disrespectful. Social interactions, peer conversations which are more familiar in the Samoan *aiga* (family) context were often used by the students although the teachers often stopped them.

Samoan language was also considered important by the participants from CS3 because they were able to manage instructions as well as the content when it was used to introduce, explore and comprehend the chemistry ideas. While the use of Samoan language were seen by some of the student participants as supports for achievements, and (more importantly) as ways to gain conceptual understanding of scientific ideas, the study found that the students were not able to demonstrate what they learnt in Samoan in the exam or tasks where the questions and responses had to be in English.

8.3.2 The nature of barriers to students' achievement

The findings from this study indicate that there are factors involving the Samoan culture, institutions (the MESC and school) and classrooms that the participants identify as barriers. The Samoan cultural values (*fa'aaloalo* and *vā fealoa'i*) were strongly embraced by the students (CS1 and CS3), which prevented them from engaging in activities (such as questioning) that the teachers wanted them to. The teachers acknowledged that questioning is an integral part of meaningful learning, and according to Chin and Osborne (2008) it is becoming a central focus of current science education reform. However, the study revealed that the students felt uncomfortable and disrespectful if they asked the teachers questions even when they recognised that they did not understand and needed help. Essentially, these students did what they practised at home, having being told by their parents not to question adults (in this study the teacher).

A lack of science resources was identified as a barrier in the three case study schools. This lack of resources included equipment and chemicals necessary for science experiment and a textbook tailored for the current curriculum. Evidence from the literature suggest that experiments are considered an important element of science teaching and learning because they allow students to learn with understanding and engage in a process of constructing knowledge by doing science (Chin, 2006; Hofstein, 2004; Hofstein & Lunetta, 2004; Kang & Wallace, 2005; Kipnis & Hofstein, 2008; K. Tobin & Llana, 2010). The students in this

study, however, missed out on these important learning approaches in science because there were no laboratory experiments carried out. Consequently, these students rely on rote learning and memorising scientific facts to pass exams. The lack of laboratory experience, however, may be the factor that influences the achievement of Pacific Island science students moving on to tertiary education where there is a high requirement for laboratory and experiment familiarity (Soti & Mutch, 2011).

The use of a lecture-style of teaching by the three teachers indicates that the students were there to receive the information that the teachers expected them to learn. This, however, prevented the students from being actively involved in experiments as well as in the learning process. Yet, the current science education/curricula and policies relating to science in Samoa emphasise active learning, where students are encouraged to gain meaningful understanding of scientific concepts. Basically, it involves active involvement in laboratory experiments and other class activities (Sesen & Tarhan, 2010) with the support of constructive and contextualised instructional strategies (Suaali & Bhattacharya, 2007) and positive learning environments (Fraser & Chionh, 2009). At the same time, the role of the teacher in monitoring and supporting these learning processes is fundamental (Taber, 2011).

8.3.3 Limitations of this study

The conclusions of this study, and the ways in which it can contribute to knowledge in the field of chemistry education, have been detailed. However, there are a number of limitations inherent in the present study. The main one lies within the problem of generalisability and transferability of the findings of this study to other teachers and schools. Case studies involve descriptive information provided by different people, and often reality is interpreted differently. For instance, the teachers and students in this study gave their perspectives of what they feel the reality is in terms of factors that influence students' achievements of Year 12 chemistry in Samoa, where other teachers may give different perspectives and emphasise different things. This allows the possibility of multiple interpretations of reality; a similar study with different participants or in a different institution with different organisation culture and context or by a different researcher may not necessarily yield the same results (Guba & Lincoln, 2008; Merriam, 2009). Essentially,

there may be a limitation in terms of generalisation of the findings from this study; however, what is identified is a reality in the nature of the phenomenon being researched.

Another limitation of this study is that the findings involve only one particular research context, that is, Year 12 chemistry in Samoa. Furthermore the data obtained was based on interviews, student work samples and observations of lessons from only one unit (hydrocarbons), involving only three teachers and five students. In this regard, the number of participants in each case study is a limitation.

Practical consideration in conducting the research also generated some limitations. In particular, the time spent in the field was limited due to the time needed for on-site arrangements, changing class schedules as well as financial constraints. Despite these limitations, this exploratory study contributes to better understanding of the factors that influence students' achievements in Year 12 chemistry in Samoa and has implications for practice.

8.4 Implications for practice

Factors affecting students' achievements in Year 12 chemistry in Samoan secondary schools were the concern of the current study. Typically, the study demonstrates a mixture of supports and barriers that involve Samoan cultural values, the MESCS as well as the school. It also describes a mismatch between the teachers' perspectives on how chemistry should be taught and students' perspectives on how to learn chemistry. Indeed, these viewpoints and perceptions are often in tension with each other. The implications of the study upon the teaching/learning of Year 12 chemistry in Samoa indicate various aspects that are not mutually exclusive and may overlap across the following attributes:

- *fa'a-Samoa* to support learning
- teachers' beliefs and classroom practice
- students' perceptions of meaningful learning
- policy and practice
- Samoan students abroad.

8.4.1 *Fa'a-Samoa* to support learning

Fa'a-Samoa or the way Samoan people do things came out very strongly in this study as a support according to the students. It was identified as a support because the students felt that if teaching and learning were carried out in ways that were more familiar to them they would have been able to learn chemistry a lot faster than being presented with sheer amount of information. Various factors of the *fa'a-Samoa* can easily be integrated into the classroom environment to support students' learning. For instance, the students did not want to challenge the teacher because it is disrespectful. Changing the learning environment from a formal education setting (teacher has full authority) to incorporate culturally responsive pedagogies may encourage students to interact. For example, using the concept of the village *fono* (meeting) where there is a mutual respect amongst village people because they know they are responsible for the well-being of the community. They share the *tōfā* and *silafā* (knowledge and understanding) through interactions where various groups of the village (such as *matai*—men or women with titles; *faletua ma tausī*—wives of chiefs and orators; *aoaluma & sa'otama'ita'i*—unmarried women out of school; *aumaga*—unmarried men out of school) are informed and are made aware of the procedures and processes of the *fono*. Although there is a village mayor (or a leader) who takes note of the decisions, everyone seated inside the meeting house is given the opportunity to express own opinions. It is less hierarchical than the formal education classroom setting and in particular it deliberately allow all *matai* members (representatives from each family in a village) to contribute ideas for the well-being of the community. In this regard, it uses peer to peer interaction which was identified by students as a support to their learning. In this setting, the teacher may propose the topic for discussion while the students (members) of the class (village) discuss in a process known to the Samoans as *fa'afaletui* (forming a gathering or meeting group to discuss an issue of importance). Sewell, St George and Cullen (2013) referred to this as sociocultural idea of developing the classroom as a learning community where “opportunities have been provided for joint participation (teacher and students) and “students began to spontaneously invite others into shared activity ... without any prompting by the teacher” (p. 51).

Another element of the *fa'a-Samoa* that could be used to support and encourage students' learning relates to the hierarchical *matai* (head of the family) system in Samoa. In such a system, the *matai* is responsible for maintaining the respect, traditions and administration of

the family, village and community. Incorporating this approach in the classroom, the teacher places the students into small groups (peers) to explore scientific concepts. Each group must have a leader to organise and make sure that each member of the group is working on the task (administration). This encourages active participation of students because they are comfortable working at that level. The teacher's role is to guide and encourage the flow of ideas and monitor students' understanding of scientific concepts. The leader of each group who is also a student can report back their group finding to share with the rest of the class.

8.4.2 Teachers' beliefs and classroom practice

The study revealed that the teachers' teaching strategies and emphasis was for students to pass exams. However, it is also important for teachers to shift their focus so that students achieve greater understanding of the relevance of chemistry to their lives. This is very important because not all students will become doctors, pharmacists, mechanics or science teachers; some of them will end up at home where they are at least able to use scientific knowledge there and in their community. For example, their scientific knowledge learned in the classroom may be able to help them decide on ways to prevent environmental and health issues that are currently common in Samoa and the Pacific generally. In fact, even if the students become doctors, pharmacists, mechanics or science teachers there is still the question about the way chemistry is learned and the way it is used in Samoa secondary schools.

The study also revealed that the teachers held strongly onto their beliefs that they have the responsibility and authority to provide the students with the knowledge primarily to pass exams rather than learn science. This may be a result of the way they were trained or experienced their own education in Samoa where they think a teacher should be the sage on the stage; a more traditional western-type classroom model. However, recent western constructivist researchers have argued that classrooms have changed into a more constructivist approach to science teaching where the teacher carefully guides the students' learning (for example; Seimears, Graves, Schroyer, & Staver, 2012; Taber, 2011). Indeed, some of the ways in which constructivists identified in their studies are perhaps more comfortably aligned with the way that people naturally learn in Samoa. For instance, the study revealed the need of students to engage in peer interaction in the classroom. Such an

approach is an important aspect of the constructivist view of learning with a foundation of science teaching and learning. In the Samoan context, these social interactions are fundamental to their day-to-day lives, where the children learn as they participate in various activities at home.

Educating teachers to change their focus away from exams may be able to ease the pressure, the feeling of discomfort and stress that teachers are experiencing in trying to meet outstanding results of students in the past. Instead, teachers should place greater emphasis on developing understanding through a process of negotiation and doing things with chemistry rather than transmission (Chin, 2006; Torrance, 2007). The findings of this study indicate that most of the students experience difficulties as they are presented with a huge amount of information that the students could not relate to their real-life situations. Even if they memorise the properties of alkanes, they are likely to forget them because they could not make any sense out of it. Thus, science education in Samoa may be difficult to improve in the area of relevancy of scientific knowledge to the students' real-life situations if the teachers' goal of teaching is to pass examination.

8.4.3 Students' perceptions of meaningful learning

Since the students in this study prefer asking their peers for clarification much more than sitting and listening to the lecture, the government and teacher education in Samoa may need to look into the ways they train those who will become teachers. The current Year 12 chemistry curriculum should be re-examined in order to incorporate teaching and learning approaches that students are comfortable with. As such, the students encourage themselves to learn and participate in activities in learning environments that promotes meaningful learning and relevant to their real-life situations. The same should be done in professional development for teachers who are already teaching chemistry. This is because the researcher recognised from teaching experience as a science/chemistry teacher in Samoa that teachers were often provided with descriptions and a huge amount of factual information during professional training. When they go back to their schools, they may present their lessons the same way as the trainer did in the professional development sessions.

The lack of sufficient science equipment and chemicals for doing experiment was evident across the three case studies, and it seemed that this has been a concern for a number of years (Ministry of Education Sports and Culture, 2007). However, the teachers and students realised the significance of doing laboratory experiments not only where “students apply knowledge and understanding to illustrate a concept ... ask questions and make predictions” (Fono-CS₃TInt) but laboratory skills also make up 10% of the SSC chemistry exam (Ministry of Education Sports and Culture, 2010). There is a need for school principals to investigate thoroughly the needs of each science subject in order to provide for them properly. Alternatively, a selected committee, including the chemistry teachers could report to the school principal about the equipment and chemicals that are required perhaps two or three times a year.

8.4.4 Policy and practice

There are various aspects already mentioned that could facilitate policy-makers to take into consideration such factors in future planning of strategies to ensure the improved teaching/learning of Year 12 chemistry in Samoa such as students’ interactions, use of Samoan language, optimum level of instruction, or a mix of teacher centered and student centred approaches. Furthermore, the study suggests that the Samoan language was helpful to some of the students to gain conceptual understanding of the chemistry concepts, however they could not express those ideas in English, particularly in the assessment tasks. If the students find the Samoan language helpful to learn chemistry then the MESC should consider the possibility of providing the SSC chemistry exam in the Samoan language, where students get to choose the version (language) of the paper that they are more comfortable with. The use of the Samoan language in the classrooms will continue to support their learning as discussed in Chapters 4, 5, 6 and 7. It also aligns with the vision of Samoan education of “recognis[ing] and realis[ing] the ... cultural potential of all students” (Ministry of Education Sports and Culture, 2006c, p. 4). However, alongside this an important task for the MESC is to look into developing programmes (from Years 9-13) to improve English language teaching and support for students, especially in rural areas. This is because the students will continue onto higher class levels where English language proficiency is a requirement.

As the teachers tried to ensure complete coverage of the requirements of the current Year 12 chemistry curriculum before the exam, they dispensed and described a lot of information (for example, notes) where students had to copy, read and eventually try to memorise. However, this promoted rote learning where very little is stored permanently in memory since what is learned by rote is easily forgotten (Johnstone & Selepeng, 2001). Perhaps a reconsideration of the scope of the current Year 12 chemistry curriculum to ensure quality rather than quantity learning could be established. This can be achieved by reducing the materials from the current curriculum and incorporating problem-based learning and field studies.

The study revealed that there was no textbook tailored for the current Year 12 chemistry curriculum. It is a concern because textbooks are the only resource where teachers can obtain explanations, descriptions and illustrations of scientific concepts. Having a textbook tailored for what they are teaching in class will be helpful for the students to stay focused on the material rather than going through heap of reading (from different textbooks), yet these different textbooks are not useful in the Year 12 chemistry because it contains materials for Year 13 and even tertiary level. Despite the lack of textbooks tailored for the current curriculum, the study revealed that the three teachers prepared notes from various sources to explain the concepts required in the curriculum. If the teachers are preparing and collecting the notes to explain the content of the curriculum, the MESC may need to consider the value of involving these teachers in such a development to produce a textbook relevant to the current curriculum with emphasis on local examples which are familiar to the Samoan students.

8.4.5 Samoan students abroad

The study reveals a number of factors associated with the ways in which the people involved in the study operate in their daily lives and *fa'a-Samoa*. If these Samoan students react to the teaching/learning of chemistry in the ways identified in this study, there is a possibility that Samoans abroad may also be experiencing similar supports and barriers. Today, Samoans tend to migrate to New Zealand for work and there are a great number of families that have been selected under the Samoan quota scheme which allow them to become citizens of New Zealand. Most of these families have children who will eventually end up in New Zealand classrooms. For these students, the use of the Samoan language

(that they are familiar with) will help them to develop confidence to live and become part of their new environment. Samoan language as a subject is now a part of the school curriculum in New Zealand. Several high schools in Auckland, Wellington, Christchurch (as well as many preschools) use or teach the language as part of their daily programme (Fetui & Malakai-Williams, 1996). However, these Samoan students may still find other subjects problematic unless a more familiar language is used or the cultural impact of *fa'a-Samoa* is recognised. The findings from this study may be worthy of consideration for the New Zealand education system, especially when it comes to why Samoan students do not ask questions in the classroom.

8.5 Future research

As indicated in the preceding section on the limitations of the study, this study involved only three Year 12 chemistry classrooms. More case studies need to be conducted with more chemistry teachers working in different settings to gain a better holistic understanding of their classroom practices and the factors that influence students' achievements. Therefore, similar studies should be carried out with teachers in different contexts such as in mission or private secondary schools and other subject disciplines.

The present study is based on the data from the interviews, samples of student work and observations of lessons from only one unit (hydrocarbons). It is also important to consider researching into other units or strands in the Year 12 chemistry curriculum to find out if the same supports and barriers exist or if the teaching/learning processes are different. For instance, one of the case study schools was found to store a huge amount of chemicals and equipment yet there was no laboratory experiment conducted at the time of this study. Such chemicals according to the teacher were suitable for other topics; others were already expired or left with no label on the containers. It would be useful to survey the type of equipment and chemicals found in the science laboratories, whether they are essential, if there is proper storage, and also if the teachers have the technical skills to use the equipment.

It is recognized that in addition to reviewing the current curriculum, assessment may also need to be reviewed as well, so that it aligns with the principles set out in the curriculum and in fact encourages a deeper understanding and relationship to the local context.

8.6 Final thoughts

The study identified supports for and barriers to students' achievements in Year 12 chemistry in Samoa. These factors, although situated within the three classrooms, are essential for science educators, school principals, policy and chemistry curriculum designers and other stakeholders as attempts are made to improve education in Samoa. Essentially, what is needed is a deeper understanding of the teaching/learning activities that occur within the classroom to inform teaching (St. George & Bourke, 2008). Thus, this exploratory study involving three case study classrooms in Samoa, can inform the MESC about the nature of support for and barriers to students' achievements.

In a society such as Samoa where teachers and parents hold high expectations for students' achievement, the realisation that their student or child has a low level of achievement can be a huge disappointment to both teachers and parents. This disappointment is indeed becoming more common in many families and many parents are questioning the purpose of schooling for their children. Such disappointment becomes a concern for education in Samoa and other Pacific nations unless educators, policy makers or the MESC consider factors that influence students learning achievement in Year 12 chemistry. This study has explored barriers and supports for student achievement in Year 12 chemistry in Samoa and has highlighted factors which suggest the need for change as well as possible directions for such change.

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Appendices

Appendix A: Letter to Chief Executive Officer

[LETTERHEAD]

[Insert Date]

Chief Executive Officer,
Ministry of Education, Sports and Culture,
PO Box (*inset number*)
Apia, SAMOA.

A Respectful Request for Conducting my Doctoral Research Investigation

Dear Sir,

Talofa lava, my name is Faguele Suaalii. I am currently living in Palmerston North, NZ, undertaking doctoral studies in education, within the School of Curriculum and Pedagogy at Massey University. My supervisors are Dr. Lone Jorgensen and Dr. Alison St. George.

As part of my doctoral studies, I am required to undertake a research investigation on any area of interest to create new knowledge and utilise the scholarship of application to refine and improve classroom practice. Therefore, I have chosen to focus on the teaching and learning processes of chemistry in order to identify and explore the barriers to achievement in year 12 chemistry in Samoa. My topic is; “Barriers to Achievement in Secondary School Chemistry: Improving Teaching and Learning of Year 12 Chemistry in Samoa”. The project explores the theory that students’ achievement and performance are indicators of quality teaching and learning.

Therefore, with respect, I, Faguele Suaalii, would like to ask for your permission to conduct this research in the following schools;

1. [*inset name of school 1*] [Urban]
2. [*inset name of school 2*] [Urban]
3. [*inset name of school 3*] [Rural]

The research investigation is proposed to invite one chemistry teacher and five year 12 chemistry students from each school to participate. Participants will be observed during their chemistry lessons and interviewed during free periods. Some of the data will be collected from archival records and work samples that students develop during the implementation of the two strands.

The researcher will ensure that the data from database, school records, teachers and students will be kept confidential and that the identity of all participants will not be disclosed in the presentation and publication of the research findings.

It is proposed that the researcher will be at the research schools mid-March 2010 to ensure that he is at the site when the selected chemistry strands are implemented. The investigation will last for two months.

If you require any further information about my research investigation, then please feel free to contact me or my supervisors using the details listed below.

Doctoral Research Student
(International Address – NZ)

(Local Address – Samoa)

<p>Faguele Suaalii</p> <p>c/- Secretary School of Curriculum and Pedagogy College of Education, Massey University, Private Bag 11 222 Palmerston North New Zealand. Tel: + 64 6 356 9099 ext 8875 (Office) + 64 27 351 8763 (Mobile) Fax: + 64 6 356 1361 Email: F.Suaalii@massey.ac.nz</p>	<p>Salelavalu Savaai Samoa Tel: + 685 778 3233 (Digicel) + 685 759 6500 (Go-Mobile) Email: F.Suaalii@massey.ac.nz</p>
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Doctoral Supervisors

<p>Dr. Lone Jorgensen</p> <p>School of Curriculum and Pedagogy College of Education Massey University, Private Bag 11 222 Palmerston North New Zealand Tel: +64 6 356 9099 ext 8702 Email: L.M.Jorgensen@massey.ac.nz</p>	<p>Dr. Alison St. George</p> <p>School of Curriculum and Pedagogy College of Education Massey University, Private Bag 11 222 Palmerston North New Zealand Tel: +64 6 356 9099 ext 8627 Email: A.M.StGeorge@massey.ac.nz</p>
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I hope for your prompt reply in this matter. Your attention in this matter is much appreciated.

Yours faithfully,

Faguele Suaalii
(Researcher)

“This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern A, Application 09/56. If you have any concerns about the ethics of this research, please contact Professor Julie Boddy, Chair, Massey University Human Ethics Committee: Southern A telephone 06 350 5799 x 2541, email humanethicsoutha@massey.ac.nz.”

Appendix B: Generic Letters to Research Schools' Principals

[LETTERHEAD]

[Insert Date]

School Principal
[Insert name of school]
PO Box *[Insert box number]*
Apia, SAMOA.

A Respectful Invitation to Participate in my Doctoral Research Investigation

Dear *[Insert name of principal]*,

Talofa lava, my name is Faguele Suaalii. I am currently living in Palmerston North, NZ, undertaking doctoral studies in education, within the School of Curriculum and Pedagogy at Massey University. My supervisors are Dr. Lone Jorgensen and Dr. Alison St. George.

As part of my doctoral studies, I am required to undertake a research investigation on any area of interest to create new knowledge and utilise the scholarship of application to refine and improve classroom practice. Therefore I have chosen to focus on the teaching and learning processes in order to identify and explore the barriers to achievement in year 12 chemistry in Samoa. My topic is; "Barriers to Achievement in Secondary School Chemistry: Improving Teaching and Learning of Year 12 Chemistry in Samoa". The project explores the theory that students' achievement and performance are indicators of quality teaching and learning.

I have contacted the CEO and his/her approval for conduction of this research at *[Insert name of school]* is attached. This letter however is to inform you about this investigation and with respect, I, Faguele Suaalii, would like to formally invite your school to be part of this investigation.

Two other government secondary schools will be invited to participate in this investigation. The researcher will invite one chemistry teacher and five year 12 chemistry students from each school. Participants will be observed during their chemistry lessons and interviewed during free periods. It is proposed that the researcher will be at the research schools mid-March 2010 to ensure that he is at the site when the selected chemistry strands are implemented. The investigation will last for two months.

The researcher will ensure that the data from database, school records, teachers and students will be kept confidential and that the identity of all participants will not be disclosed in the presentation and publication of the research findings.

For further information about my research investigation, please feel free to contact me or my supervisors using the details listed below.

Doctoral Research Student

(International Address – NZ)

(Local Address – Samoa)

Faguele Suaalii c/- Secretary School of Curriculum and Pedagogy College of Education, Massey University, Private Bag 11 222 Palmerston North New Zealand. Tel: + 64 6 356 9099 ext 8875 (Office) + 64 27 351 8763 (Mobile) Fax: + 64 6 356 1361 Email: F.Suaalii@massey.ac.nz	Salelavalu Savaii Samoa Tel: + 685 778 3233 (Digicel) + 685 759 6500 (Go-Mobile) Email: F.Suaalii@massey.ac.nz
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Doctoral Supervisors

Dr. Lone Jorgensen School of Curriculum and Pedagogy College of Education Massey University, Private Bag 11 222 Palmerston North New Zealand Tel: +64 6 356 9099 ext 8702 Email: L.M.Jorgensen@massey.ac.nz	Dr. Alison St. George School of Curriculum and Pedagogy College of Education Massey University, Private Bag 11 222 Palmerston North New Zealand Tel: +64 6 356 9099 ext 8627 Email: A.M.StGeorge@massey.ac.nz
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I hope for your prompt reply in this matter. Your attention in this matter is much appreciated.

Yours faithfully,

Faguele Suaalii
(Researcher)

“This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern A, Application 09/56. If you have any concerns about the ethics of this research, please contact Professor Julie Boddy, Chair, Massey University Human Ethics Committee: Southern A telephone 06 350 5799 x 2541, email humanethicsoutha@massey.ac.nz.”

Appendix C: Information Sheet – Teacher Participants

[LETTERHEAD]

Title:

Barriers to Achievement in Secondary school Chemistry: Improving Teaching and Learning of Year 12 Chemistry in Samoa.

INFORMATION SHEET

TEACHER PARTICIPANTS

Researcher's Introduction

Talofa lava, I will introduce myself and then I will invite you to take part in this investigation. My name is Faguele Suaalii. I am now living in Palmerston North (NZ), studying in education within the School of Curriculum and Pedagogy at Massey University.

My area of interest is central to improving students' achievement and performance in secondary school chemistry in Samoa. The current research investigation gives you (teacher) the opportunity to reflect about teaching quality necessary for improving students' achievement and performance in chemistry. The investigation targets the first two chemistry strands, namely; the *Structure of Atoms* and *Quantitative and Physical Chemistry* in the year 12 chemistry curriculum.

What is the purpose of this investigation?

The purpose of this investigation is to explore barriers to students' achievement in chemistry and ways to assist in improving teaching and learning of year 12 chemistry in Samoa. I will be collecting information about the teaching processes; the ways teachers encourage and monitor students' learning and the different pedagogies used. As this research aims to gather information from both teaching and learning processes, I would sincerely like to invite you, as a chemistry teacher, to participate in this investigation. Please keep in mind that the researcher is here to learn from you and your experiences as a year 12 chemistry teacher in a Samoa secondary school. The researcher will ensure that the data from this investigation will be kept confidential and that the identity of all participants will not be disclosed in the presentation and publication of the research findings.

Who is involved?

The researcher will invite one chemistry teacher and five year 12 chemistry students from each of three participating schools. However, if more students choose to be involved, participants will be selected at random.

What is involved?

In agreeing to participate, have a look at the consent form, think about it and if you would like to participate, please bring them back to me by *[Insert date]*. This form gives your permission to be involved in all data collecting methods involved. Your identities will be kept confidential from each other and in any publication.

The proposed starting date is mid March 2010 and lasts for two months. The researcher ensures that the investigation will not affect your working/school hours. For classroom observations, you will be observed during the instruction of the two strands (no additional time required) and interviews will be conducted during your free periods or after school.

Researcher's role:

- The researcher will conduct classroom observation while the two strands are taught. This means that the researcher will be inside the classroom or laboratory during your chemistry classes and/or experiments. There will be three classroom observations for each strand.
- There will be two interview sessions, one for each strand. Individual participant will be interviewed twice. Each participant will be interviewed for forty minutes of your free time. With your agreement, the interviews will be audio recorded in order to provide the researcher with more time to concentrate on what individual participant is trying to say rather than trying to write it all down.

Participant's roles:

- It is important also that you (as participants) understand that participation is voluntary and the information collected will not affect your;
 - o reputation as a teacher;
 - o annual salary;
 - o future job opportunities;
 - o teaching profession; and, your
 - o annual report;
- You are under no obligation to accept this invitation, and your decision will not affect you and your work. If you decide to participate, you have the rights to:
 - o decline to answer any particular question during the interview;
 - o withdraw yourself and the information you have contributed (classroom observations and interview) from the research investigation up until interview transcripts are finalized;
 - o ask any question about the study at any time during participation;
 - o provide information on the understanding that your name will not be used unless you give permission to the researcher;
 - o be given access to a summary of the project findings when it is concluded; and,
 - o have the audio recording turned off at any time during the interviews.

What happens to the Data?

The data from this investigation will be transcribed and analysed to identify the impacts of barriers to achievement in year 12 chemistry in Samoa, specifically in the two chemistry strands. The data will be used by the researcher to complete a thesis in fulfillment of a doctoral degree in education. The data will be kept confidential and secured in my office computer (Massey University) which is password protected-so that no one can access it. Hard copies and audio tapes will be securely locked in a filing cabinet in my office and will eventually be destroyed after transcription into the thesis publication.

Who to contact if you have questions?

If you wish to discuss any concern or if you have any question about this research investigation, please do not hesitate to contact the researcher:

Salelavalu
Savaai
Samoa
Tel: + 685 778 3233 (Digicel)
+ 685 759 6500 (Go-Mobile)
Email: F.Suaalii@massey.ac.nz

Alternatively you can contact my supervisors:

Dr. Lone Jorgensen School of Curriculum and Pedagogy College of Education Massey University, Private Bag 11 222 Palmerston North New Zealand Tel: +64 6 356 9099 ext 8702 Email: L.M.Jorgensen@massey.ac.nz	Dr. Alison St. George School of Curriculum and Pedagogy College of Education Massey University, Private Bag 11 222 Palmerston North New Zealand Tel: +64 6 356 9099 ext 8627 Email: A.M.StGeorge@massey.ac.nz
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“This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern A, Application 09/56. If you have any concerns about the ethics of this research, please contact Professor Julie Boddy, Chair, Massey University Human Ethics Committee: Southern A telephone 06 350 5799 x 2541, email humanethicsoutha@massey.ac.nz.”

Appendix D: Consent Form – Teacher Participants

[LETTERHEAD]

Barriers to Achievement in Secondary school Chemistry: Improving Teaching and Learning of Year 12 Chemistry in Samoa.

CONSENT FORM

TEACHER PARTICIPANTS

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

Please Tick the appropriate box

I agree do not agree to being observed in the classroom

I agree do not agree to be interviewed.

I agree do not agree to the interview being sound recorded.

I wish do not wish to have my recordings returned to me.

I agree to participate in this study under the conditions set out in the Information Sheet.

Signature:

Date:

Full Name - printed

Appendix E: Information Sheet – Student Participants

[LETTERHEAD]

Title:

Barriers to Achievement in Secondary school Chemistry: Improving Teaching and Learning of Year 12 Chemistry in Samoa.

INFORMATION SHEET

STUDENT PARTICIPANTS

Introduction

Talofa lava. First I will introduce myself (researcher), and then I will invite you to take part in this investigation. My name is Faguele Suaalii. I am now living in Palmerston North (New Zealand), studying in education within the School of Curriculum and Pedagogy at Massey University. This investigation gives you the opportunity to reflect about your learning experiences and to show how you understand the scientific ideas of the first two strands; the *Structure of Atoms* and *Quantitative and Physical Chemistry* in the year 12 chemistry curriculum.

What is the purpose of this investigation?

The purpose of this investigation is to explore the barriers to students' achievement in chemistry and ways to assist in improving teaching and learning of year 12 chemistry in Samoa. This means that I will be collecting information about your understanding of the two chemistry strands by exploring how you learn; what you learn and understand; and how learning achievement is reflected in work samples you develop in class. As this research aims to gather most of the information from year 12 chemistry students, I would like to invite you to participate in this investigation. Please keep in mind that the researcher is here to learn from you and your experiences as year 12 chemistry students in Samoa. The researcher will ensure that the data from database, school records, teachers and students will be kept confidential and that the identity of all participants will not be disclosed in the presentation and publication of the research findings.

Who is involved?

The researcher will invite one chemistry teacher and five year 12 chemistry students from each of three participating schools. However, if more students choose to be involved, participants will be selected at random.

What is involved?

In agreeing to participate, you are welcome to take the consent forms home, have a think about it and if you would like to be involved, please bring them back to me by *[Insert date]*.

This form gives your permission to be involved in all data collecting methods throughout this investigation; however you have the right to withdraw at any time. Your identities will be kept confidential from each other, from your teacher and, in any publication of the data from this investigation.

The proposed starting date is mid March 2010 and lasts for two months. The researcher ensures that the investigation will not affect your school hours. Classroom observations will be conducted during the instruction of the two strands (no additional time required) while interviews during your free periods.

Researcher's role:

- The researcher will be collecting some information from the school admission records about your previous performance and achievement in junior sciences. As well, information such as national exam results will be collected from MESC's database.
- The researcher will conduct classroom observations while the two strands are instructed. This means that the researcher will be inside the classroom or laboratory during your chemistry classes and/or experiments. There will be three classroom observations for each strand.
- A sample of work that you develop in class will be collected after it has been assessed by your chemistry teacher.
- There will be two interview sessions, one for each strand. Individual participant will be interviewed twice. Each participant will be interviewed for forty minutes of your free time. With your agreement, the interviews will be audio recorded in order to provide the researcher with more time to concentrate on what individual participant is trying to say rather than trying to write it all down.

Participant's roles:

- It is important also that you understand that participation is voluntary and the information collected will not affect your;
 - o school performance and report;
 - o subject grade or mark;
 - o subject achievement and performance;
 - o internal assessment grades/marks; and,
 - o School Certificate results.
- You, as participants in this investigation are under no obligation to accept this invitation, and your decision will not affect your results or achievement in chemistry. If you decide to participate, you have the rights to:
 - o decline to answer any particular question during the interview;
 - o withdraw yourself and the information you have contributed (archival information, classroom observations, work samples and interview) from the research investigation up until interview transcripts are finalized;
 - o ask any question about the study at any time during participation;
 - o provide information on the understanding that your name will not be used unless you give permission to the researcher;
 - o be given access to a summary of the project findings when it is concluded; and,
 - o have the audio recording turned off at any time during the interviews.

What happens to the Data?

The data from this investigation will be transcribed and analysed to identify the impacts of barriers to achievement in year 12 chemistry in Samoa, specifically in the two chemistry strands. The data will be used by the researcher to complete a thesis in fulfillment of a doctoral degree in education. The data will be kept confidential and secured in my office computer (Massey University) which is password protected-so that no one can access it. Hard copies and audio tapes will be securely locked in a filing cabinet in my office and will eventually be destroyed after transcription into the thesis publication.

Who to contact if you have questions?

If you wish to discuss any concern or if you have any question about this research investigation, please do not hesitate to ask the researcher.

Salelavalu
Savaii
Samoa
Tel: + 685 778 3233 (Digicel)
+ 685 759 6500 (Go-Mobile)
Email: F.Suaalii@massey.ac.nz

“This project has been reviewed and approved by the Massey University Human Ethics Committee: Southern A, Application 09/56. If you have any concerns about the ethics of this research, please contact Professor Julie Boddy, Chair, Massey University Human Ethics Committee: Southern A telephone 06 350 5799 x 2541, email humanethicsoutha@massey.ac.nz.”

Appendix F: Consent Form – Student Participants

[LETTERHEAD]

Title:

Barriers to Achievement in Secondary school Chemistry: Improving Teaching and Learning of Year 12 Chemistry in Samoa.

CONSENT FORM

STUDENT PARTICIPANTS

I have read the Information Sheet and have had the details of the study explained to me. My questions have been answered to my satisfaction, and I understand that I may ask further questions at any time.

Please Tick the appropriate box

I agree do not agree to being observed in the classroom

I agree do not agree to be interviewed.

I agree do not agree to the interview being sound recorded.

I wish do not wish to have my recordings returned to me.

I agree to participate in this study under the conditions set out in the Information Sheet.

Signature:

Date:

Full Name - printed

Appendix G: Generic Letter for Accessing Student Participants' Achievement Records

[LETTERHEAD]

[Inset Date]

A Respectful Request to Access Your Archival Records

Dear Student Participant,

With respect I, Faguele Suaalii, would like to seek your permission to access the information recorded in the School's Admission Records concerning your achievement and performance in science in the past years. I will also be requesting your science exam results from the Ministry of Education, Sports and Culture's Database.

This information is for the purposes of this research investigation and no information will be revealed to others. I will also make sure that your identities will be kept confidential in the reporting of findings from this investigation.

For further information, please feel free to contact me using the details listed below.

Salelavalu
Sava'i
Samoa
Tel: + 685 778 3233 (Digicel)
+ 685 759 6500 (Go-Mobile)
Email: F.Suaalii@massey.ac.nz

Yours sincerely,

Faguele Suaalii
(Researcher)

Please complete the following and return to the researcher.

Please tick the appropriate box

I agree do not agree to allow the researcher to access the information requested.

Signature: _____ Date: _____

Full Name – printed _____

Appendix H: Letter for Accessing Schools' Admission Records

[LETTERHEAD]

[Insert Date]

Principal,
(Insert School Name),
Apia, SAMOA.

A Respectful Request to Access School's Admission Records

Dear Sir/Madam,

With great respect I, Faguele Suaalii, would like to seek your permission to access the School's Admission Records to gain some information concerning the student participants' achievement and performance in science. This information will be analysed and be used together with the information collected from the classroom settings to assist in exploring the barriers to achievement in chemistry.

This information is for the purposes of this research investigation and no information will be revealed to others. I will also make sure that the school and participants' identities will be kept confidential in the reporting of findings from this investigation.

For further information, please feel free to contact me using the details listed below.

Salelavalu Sava'i Samoa Tel: + 685 778 3233 (Digicel) + 685 759 6500 (Go-Mobile) Email: F.Suaalii@massey.ac.nz

I hope for your prompt reply in this matter. Your attention to this matter is much appreciated.

Yours faithfully,

Faguele Suaalii
(**Researcher**)

Appendix I: Interview Guiding Questions – Teacher Participants

Semi structured Interview

The following questions serve as guidelines to how the interview will progress.

Duration of interview: 40 minutes

Introduction:

Talofa and thank you once again for taking part in this investigation!

The questions focus on the teaching and learning processes of the third strand; **organic chemistry**. There are questions relating to your teaching experience and classroom observations. There are no right or wrong answers to these questions; I am interested in what you have to say.

Feel free to stop the recording at any time during the interview if you feel uncomfortable.

Questions about teaching experience and process

1. How long have you been teaching year 12 chemistry?
2. How confident do you feel about your knowledge of hydrocarbons?
3. How helpful are the students' text books, students' learning guides, curriculum and resources available to the teaching of hydrocarbons?
4. How did you select your teaching methods/strategies to be used?
5. How did you feel about students' learning of hydrocarbons?
6. When you were planning, what were some of the areas that you needed to address during the instruction this strand? Did you feel that your planning was successful? Why and why not? How did you find out?
7. How do you identify that your lesson is successful? Is there anything that you would like to do differently?
8. What would you like to be implemented or changed if you have to reteach the occurrence, properties and preparations of hydrocarbons? Why?

Questions related to classroom observation

9. How do you describe the achievement of your students in this strand? How do you measure students' achievement?
10. How do you feel about asking questions to which students do not respond?
11. How do you assess your students' achievement of hydrocarbons or in chemistry? Why and how often do you assess your students' achievement?
12. What are some of the difficulties you encountered while teaching this strand?
13. What were the purposes of the work/activity that students did in class?
14. How do you classify your students' achievement of this strand? (1 – 9 – teachers are familiar with this with 1 being the best).
15. What achievement level would you want your students to have, explain why?
16. Do you think it is useful for students to talk about/discuss ideas with each other and with you?
17. How many students are there in the chemistry class that you teach?
18. Do you think these students will continue on to Year 13 chemistry? If not, why not?

Appendix J: Interview Guiding Questions – Student Participants

Semi structured Interview

The following questions serve as guidelines to how the interview will progress.

Duration of interview: 40 minutes

Introduction:

Talofa and thank you once again for taking part in this investigation!

The questions focuses on the teaching and learning processes of the third strand; **organic chemistry**. There are also questions relating to the classroom observations, archival records and the work sample I collected. There are no right or wrong answers to these questions; I am interested in what you have to say.

Feel free to stop the recording at any time during the interview if your feel uncomfortable.

Questions about teaching and learning processes

Why did you choose to enrol in year 12 chemistry?

1. How did you feel about the teaching of hydrocarbons? Did you feel it was taught clearly?
2. Could you tell me what you learnt about hydrocarbons?
3. Did you encounter any problems while trying to learn hydrocarbons? Can you explain them to me?
4. How would you like a teacher to teach hydrocarbons?

Questions relating to the work samples/ activity

5. How often you do activities in class? How long does it take you to do one activity?
6. Before doing this task, did you understand the requirements/purposes for doing it?
7. How useful is the work that you did in class to your learning of the material as well as your achievement in chemistry?
8. How do the teachers' comments and remarks help you learn or understand hydrocarbons? How does the feedback from the teacher assist you in the next task?
9. What does the mark/grade/comment that the teacher wrote on your work mean to you? How does this affect your achievement in hydrocarbons?
10. What factors influenced the choices you made while working on these tasks? How much input did you have in any decision making process?

Questions relating to the classroom observation

11. How would you want the classroom organisation, practice in order to help promote your learning of hydrocarbons?
12. How do you feel about asking questions during discussions? Do you ask questions if you don't understand something, or not sure what to do, or want to know more? Why or why not?
13. During note copying, do you understand what is going on? How do you normally demonstrate to the teacher that you either understand a topic or do not understand it?

Appendix K: Teacher Participants – Authority for Release of Transcripts

[LETTERHEAD]

Title:

Barriers to Achievement in Secondary school Chemistry: Improving Teaching and Learning of Year 12 Chemistry in Samoa.

AUTHORITY FOR RELEASE OF TRANSCRIPTS

TEACHER PARTICIPANT

I confirm that I have had the opportunity to read and amend the transcript of the interview(s) conducted with me.

I agree that the edited transcript and extracts from this may be used by the researcher *Faguele Snaalii* in reports and publications arising from the research.

Signature: _____ **Date:** _____

Full Name - printed _____

Appendix L: Student Participants – Authority for Release of Transcripts

[LETTERHEAD]

Title:

Barriers to Achievement in Secondary school Chemistry: Improving Teaching and Learning of Year 12 Chemistry in Samoa.

AUTHORITY FOR RELEASE OF TRANSCRIPTS

STUDENT PARTICIPANT

I confirm that I have had the opportunity to read and amend the transcript of the interview(s) conducted with me.

I agree that the edited transcript and extracts from this may be used by the researcher *Faguele Snaalii* in reports and publications arising from the research.

Signature: _____ Date: _____

Full Name - printed _____

Appendix M: Letter of Ethics Approval



Massey University

8 October 2009

Mr Faguele Suaalii
1D Hereford Street
West End
PALMERSTON NORTH

Dear Faguele

Re: HEC: Southern A Application – 09/56
Barriers to achievement in Secondary School Chemistry: Improv
of Year 12 Chemistry in Samoa

Thank you for your letter received 25 September 2009.

On behalf of the Massey University Human Ethics Committee: Southern A, that the ethics of your application are now approved. Approval is for three years. If the application has not been completed within three years from the date of this letter, reapproval must

*Please note that travel undertaken by students must be approved by the super
Vice-Chancellor and be in accordance with the Policy and Procedures for
Travel Overseas. In addition, the supervisor must advise the University's Inst*

If the nature, content, location, procedures or personnel of your approved application change, please advise the Secretary of the Committee.

Yours sincerely

Appendix N: Approval Letter from MESC's CEO



Please address all
correspondence to the
Chief Executive Officer

GOVERNMENT OF SAMOA
MINISTRY OF EDUCATION, SPORTS & CULTURE

P.O. Box 1869, Apia, SAMOA Telephone (0685) 21 911 Facsimile (0685) 21917 Email: samoamesc@lesamoa.net

25 November 2009

Mr. Faguele Suaalii
Doctoral Student
School of Curriculum and Pedagogy
College of Education
Massey University
Private Bag 11 222
Palmerston North
NEW ZEALAND

Re: "Barriers to Achievement in Secondary School Chemistry: Improving Teaching and Learning of Year 12 Chemistry in Samoa" Research

Dear Faguele,

Thank you for your letter dated 9th October 2009 requesting for permission to conduct the above research. The Ministry has considered your request and has granted approval for you to conduct your research [REDACTED] with the hope that the findings will help improve the teaching and learning experiences of teachers and students alike. In doing so, will assist in the Ministry's efforts to improve education in Samoa.

At this stage, we wish to request that a copy of your full research proposal be sent to us for our records. We would also request that you provide:

- the list of MESC documents and Personnel, or data that you require to use
- an outline of how you propose to use the findings, and who will have access to these findings, and whether the findings will be available to the public

If you agree to the conditions stated in the MESC's **Guidelines to Managing and Conducting Research** (p.3) attached, please sign our agreement form and return it to the Policy, Planning and Research Division's (PPRD) Research and Policy Unit. Your MESC liaison person for your research project is Quandolita Reid-Enari.

Should you require further information/clarification, please do not hesitate to contact Marie Bentin-To'alepaialifi on telephone 21911 ext. 720 or Quandolita Reid-Enari on telephone 21911 ext. 722 at the Policy, Planning and Research Division.

Good luck with the research and looking forward to read your findings.

Sincerely

A handwritten signature in cursive script, appearing to read "Galumalemana Nuufou Petaia".

Galumalemana Nuufou Petaia
CHIEF EXECUTIVE OFFICER

Encl: Conditions for Research
Research Agreement Form