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THE PURPOSE OF DOING PRACTICAL SCIENCE ACTIVITIES IN URBAN AND RURAL SECONDARY SCHOOLS IN SOLOMON ISLANDS

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Abstract

Internationally many science educators have argued that science teachers should ensure that their students have opportunities to engage with and take part in practical work, in order to better understand natural phenomena and learn how science tries to understand and explain these. However, there is ongoing debate about the specific purpose of carrying out practical science activities. Some research suggests that if practical investigations are not prepared well enough, they may not have much impact on improving students' learning about science. This research study involved two secondary science teachers teaching Form 2 science in urban secondary schools and two from rural. The overarching aim was to explore the science teachers' perceptions about the purpose of doing practical science activities in secondary schools. The study was conducted in two phases. First, based on the interpretive paradigm qualitative data was generated using semi-structured interview of each teacher. In the second phase the teachers involved in a photo elicitation process where each teacher took photographs of examples of practical science activities they organized for their students. This was followed by a second round of interviews where the teachers told the stories about the photographs they have taken. The data was then analyzed using the grounded theory method. The findings suggest that these teachers saw the purposes of doing practical science activities was to apply theoretical knowledge they learned about in class, develop thinking and process skills, motivate students and raise their interest in science. However, the teachers were not able to articulate the rationale behind doing practical science activities and did not identify it as an important aspect of science. The findings also noted the science syllabus and assessment, impact of access to science resources, training, time and class size as enablers and constraints which science teachers encounter in planning and organizing practical science activities. The findings also showed that there were differences between science teachers in urban and rural secondary schools on how they plan and organize practical science activities. The differences in how schools and science departments were equipped meant that teachers were resourceful and made use of their immediate environment when materials were scarce however they felt that 'lab' is best.

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Chapter One: Introduction

This chapter provides the introduction to this study. The chapter starts with a brief rationale for considering practical science activities teachers plan for in Solomon Islands, then deliberates on the purpose of the research and states the underlying questions of this research study. Attention is drawn to the significance of the research study followed by a section on the context of the study. Finally, an overview of the following chapters is presented.

1 Rationale

Internationally many science educators have argued that science teachers should ensure that their students have opportunities to engage with and take part in practical work, in order to better understand natural phenomena and learn how science tries to understand and explain these (Coughlin & Hannafin, 2003; Gott & Duggan, 2007; Woolnough, 1983). However, there is ongoing debate about the specific purpose of carrying out practical science activities. Some research suggest that if practical investigations are not prepared well enough, they may not have much impact on improving students' learning about science (Hofstein & Mamlok-Naaman, 2007; Millar, 2009).

It has been argued that practical activities in science enhance students' understanding of science concepts; help students acquire personal and process skills as well as instilling curiosity and motivation for science (Woodley, 2009). However science teachers have to be knowledgeable about what it means to be engaged in practical science activities. This is important so that when they plan or organize practical science activities they know exactly the outcome they intend their students to learn. Some of these outcomes may be related to promoting students' understanding of science concepts; skills important for learning science and appreciation of the value of the work of science (Sulaiman, Suan, & Abdullah, 2009). As practical work is an important component of science it is important for teachers to have a good understanding of its purpose and importance so they can plan and organize practical science activities that enhance students' learning in science.

It is the intention of this research study to investigate views of science teachers from Solomon Islands about what they see as the purpose for science activities and examples of the activities they usually engage in. This research study will also report the factors that influence science teachers when planning when planning and organizing practical work. Little is known about Solomon Islands science teachers' ideas and practices around practical activities and this study aims to provide some insights.

1.1 Purpose of the Study

The overarching purpose of this research is to explore and document the perceptions of four Form 2 science teachers about the purpose of doing practical science activities in secondary schools. Furthermore this research study aims to gain more understanding on the science teachers' reflections that influence their decisions to plan, design and conduct practical science activities with their students. To achieve this, semi-structured interviews with photo elicitation methods were deployed to generate qualitative data from the participants.

It is hoped that the findings will inform other science teachers and researchers about the teachers' perceptions to shed some light on what practical science activities are being included into the science teaching and what significance the teachers reported in doing so. The study also wants to identify whether there are any noticeable differences between the reported practices of urban and rural teachers. Currently Solomon Islands is reviewing the primary and secondary curriculum therefore this study may provide additional information for curriculum developers.

Therefore the underlying questions of this research study were;

1. What are F2 urban and rural secondary science teachers' perceptions about the purpose of practical science activities?
2. What do teachers report about their experiences in carrying out practical science activities?
3. Are there differences between urban and rural schools?

1.2 Significance of the research project

This study aims to provide new knowledge to the area of science education on how science teachers in Solomon Islands view the purpose of carrying out practical science activities. Generally, there is consensus among science educators that doing practical science activities is an important aspect of studying science (Anderson, 2002; Fullick, 2004; Hodson, 2005; Richardson, Sharma, & Khachan, 2008; Staer, Goodrum, & Hackling, 1998). Brown (1995 as cited in Kapenda, Kanjeo-marenga, Kasanda, & Lubben, 2002, p. 54) noted that there are different types of practical science which include; “exercises to develop specific skills; investigations including hypothesis testing or problem solving; experiments to introduce students to particular phenomena; demonstrations to allow the teacher to develop a scientific argument or create a dramatic impression; and fieldwork”.

However, there has been a change in how science educators view the roles that practical science activities play in enhancing students understanding of concepts and improving their process skills (Hoftsein & Lunetta, 2004). Millar (2009) for example argued that practical activities do not enhance students learning in science at all unless the purpose of practical work is fully understood by science teachers and students. Also, practical work on its own may not promote learning unless it is supported through other teaching strategies (Gatt, (2004). Given the diversity in view points being debated amongst researchers about the purpose and benefit of carrying out practical science activities, this small study is thought to be significant because it will explore the views of four science teachers teaching Form 2 in urban and rural secondary schools in Solomon Islands in respect to the debate and benefits about practical science activities.

Furthermore, this study is significant because it will report the activities the teachers are choosing to do with their students as research suggested that practical science activities vary depending on the intended outcome of the activity (Woodley, 2009). Science teachers need to be knowledgeable and well prepared to be creative and innovative to address the many challenges whether these are content or pedagogically related. Fishman and Krajcik (2003) noted that science teachers need to understand the importance of the notion of science innovations to address the many challenges encountered in this century. Innovation means being able to improvise with whatever materials available to the science teachers to plan and organize practical science activities. Currently that Solomon Islands' school curriculum is under review, the findings of this study may provide curriculum developers with ideas about developing science activities that may be used in urban as well as rural or remote secondary schools.

Therefore this research study is timely to record the views and experiences of science teachers teaching in the rural and remote Solomon Islands and present the challenges they encounter in carrying out practical science activities.

1.3 Motivation to undertake this study

The interest to undertake this research study was based on the researcher's own experience as a student, a science teacher and as a member of the Science Advisory Committee (SAC) to review the primary and secondary science syllabus of Solomon Islands. The first motivating factor for undertaking this research study was the challenge the researcher encountered himself when planning and designing practical work for students in Forms one to five in Solomon Islands. Resources suggested in the science syllabus to carry out practical science activities were not always available thus making practical investigations challenging at times.

Above all, the main interest in undertaking this research study was based on the challenges encountered by the researcher in trying to suggest practical science activities to be included in the primary and secondary science syllabi that were in the process of review.

1.4 Context of study

1.4.1 Solomon Islands

This study took place in two rural schools in Santa Isabel and two urban schools in Honiara the capital of Solomon Islands on Guadalcanal. Santa Isabel and Guadalcanal are amongst the six main islands that make up Solomon Islands.

Solomon Islands are one of the young nations in the western pacific region where 90% of its people live in rural agrarian communities with strong ties to their traditional beliefs, way of life and the land. Solomon Islands is the third largest archipelago in the Oceania region, with a coastline that stretches over 5,313 kilometres and land mass of approximately 27,986 square kilometres comprising of six main islands and about one hundred smaller ones (Honan & Harcombe, 1997). The total population of Solomon Islands for 2010 was estimated to be around 559,198 people, with Melanesians (94.5%) who live in the larger islands; Polynesians (3%) who occupy the outlying islands and atolls; Micronesians (1.2%) and other ethnicities (1.1%). Eighteen percent of the total population live in urban areas with an annual urbanisation rate of 4.1 percent (CIA, 2010; Honan & Harcombe, 1997).There are about 120 languages spoken in Solomon Islands where pigin or what is commonly known as broken English is the common vernacular while English is regarded as the official language which is only spoken by 1-2% of the total population.

Solomon Islands was a British Protectorate since the 1890s and gained self government in 1976 and eventually an independent nation from the 7th of July 1978 and adopted the Westminster governing system (CIA, 2010). With the devolution of powers in 1981 the government was further decentralized into a total of nine provinces to date. The provincial governments looked after their own affairs although most of the funding comes from the central government. As a nation Solomon Islands has always struggled economically therefore its economy has been supported through aid money from other development partners including Australia and New Zealand. It was even worse and on the verge of collapse when law and order was in the hands of ethnic militants from 1998 to 2003 until when the Regional Assistance to Solomon Islands(RAMSI) headed by Australia and New Zealand was deployed (CIA, 2010). This has also impacted a lot on Solomon Islands education system.

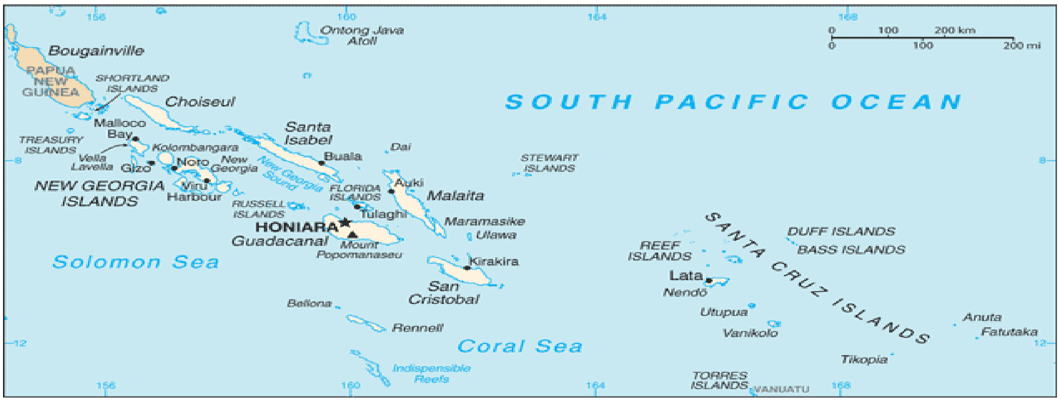

Figure 1 Map of Solomon Islands, position 8° S and 159° E (source CIA, 2010)

1.4.2 Education system in Solomon Islands

The development of formal education in Solomon Islands can be traced back to the era of missionaries and the colonialism since the 1940s. As in most developing nations, the early syllabuses were imported and in the case of Solomon Islands' science syllabus were modeled very closely to those used in British secondary schools.

The education system of the Solomon Islands is governed by the Education Act of 1978 (p. 67). This act sets the laws that govern the decentralization and administration of schools including secondary schools. Wasuka (1989) reported that there were only two schools (a government school and an Anglican school) that provided the first opportunity for secondary education in the late 1960s. From then on other church denominations had their own schools that offered secondary education. By 1978 when Solomon Islands gained its independence there were only six national secondary school (five owned by churches and one government school) which adopted a science syllabus similar to the British Education system. However, in 1974 a policy ('Education for [what]?') was formulated to contextualize the objectives of secondary education (Ministry of Education and Human Resource Development, 1974). This policy led to the introduction of provincial secondary schools which used a slightly different syllabus from the earlier ones used. The imperative of these schools was to train young Solomon Islanders to utilize their own resource and science was often not included as part of the subjects offered. Instead the two most important subjects taught were agriculture and home economics. However, wide spread dissatisfaction about the diverse range of school curricula since the implementation of the 'Education for what' policy led to the adoption of a unified secondary school curriculum that came into effect in 1978. To date there are three types of secondary schools that offer secondary education in Solomon Islands, 80% of them are in rural and remote areas and science is a core subject from Forms one to five (Solomon Islands Government Ministry of Education and Human Resource Development annual report, 2007). The three types of secondary schools are National Secondary schools, Provincial secondary schools and Community High Schools. To enter into secondary education system students write the national secondary entrance exam at grade six. While students are given the choice to select which secondary school they wish to go to, the marks they get in this exam determines the actual secondary school they are placed in. Students with very high marks are placed in the National Secondary Schools, followed by Provincial and Community High Schools.

1.4.3 Science education in Solomon Islands

Science education in the Solomon Islands has gone through a difficult development over the years (Cronin, 2005). Smith (2009, p. 1) a visiting consultant from the Australian Catholic University(ACU) who conducted a workshop with forty secondary science teachers at St. Josephs Tenaru Catholic Secondary school in Honiara city the capital of Solomon Islands in 2007 and 2008 highlighted in a report to the Catholic Education Authority in Solomon Islands the following as constraints to the teaching and learning of science in secondary schools;

> In the Solomon Islands it suffers from both lack of teacher education and accessible equipment. As a result, science teaching tends to be of poor quality, with teachers relying on often outdated texts with little or no practical work being carried out (Smith, 2009, p. 1).

The sentiments aired by Smith have been issues of concern by science educators and teachers in Solomon Islands ever since the post colonial era. Taylor, Vlaardingerbroek and Coll (2004) asserted that the effect of colonialism on the education system of most countries in the South Pacific will take a very long time to change. The main concern is related to the schools maintaing the same set of science activities and resources that were used during the colonial domination. This concern has been identified by some science educators and proposed to the Ministry of Education for a review in the science curriculum which began in the 1990s and more recently the reform of the primary and secondary science syllabus which commenced in 2003 as stipulated in the 2004 annual report (Solomon Islands Ministry of Education, 2004).

A study conducted by Hayes (1992) argued on the basis of his study why the majority of first year university science students from Solomon Islands studying science failed, suggested that with lack of students understanding about science from their primary and secondary education. This generalization may still have some merit today as 90% primary students who enter secondary education are from rural areas where science is not a core subject to be examined to enter secondary education so teachers may not put much emphasis on science. A report by UNICEF has pointed out countries in the South Pacific including Kiribati, Vanuatu and Solomon Islands is heavily dominated by rote learning and that does not allow the students to solve problems by themselves (UNICEF report, 2009).

However, in its Education Strategic Plan for 2004 to 2015, the Solomon Islands government through the Ministry of education is embarking on improving the status of science education (Solomon Islands Ministry of Education, 2000). This includes the formulation of a new education philosophy which aims to provide science education for all; the reviewing of the primary and secondary school curriculum including science; and training more primary and secondary school science teachers; and finally increasing the availability of science resources to all primary and secondary schools.

1.5 Summary and chapter outline

This chapter presented a brief introduction and rationale about this study that seeks to gain insights into Solomon Islands secondary science teachers' ideas about doing practical work with their students. This study is sought to be significant because it will provide new knowledge to research and this has been discussed in this chapter. Further, the context of the study has been discussed emphasizing on the developments that contributed to shape the education system of Solomon Islands.

The literature review will be presented in chapter two followed by the methodology in chapter three. Chapter Three describes the research design that underpinned this study. Chapter four outlines the findings of this study. Chapter five presents the discussion and highlighting the implications and limitations of this study and the researcher's final thoughts.

Chapter Two: Literature review

2 Introduction

This chapter presents the literature review. The first section reviews what research has reported about the nature of science and what it means to learn science. The review will then explore views about the nature of science and the role science teachers play in ensuring learners understand what science is about. The literature review continues to examine the purpose of doing practical science activities at secondary schools and science teachers' ideas about practical science activities. The final section in this chapter will summarize the major points discussed in the literature review and highlight the areas in the literature this research intends to contribute to.

2.1 The nature of science

The question about the nature of science is an important one to understand as it forms the basis of what science is. Although there is no absolute definition about the nature of science, one way to view the nature of science is to consider what is meant to be scientifically literate (Withely, Miller, Durant, Evans and Thomas as cited in Bell, 2009). They noted that there are three characteristic domains that can be used to view the nature of science which include; science as a body of knowledge; and a set of methods/processes and a way of knowing. It can be noted that the first domain is concrete as scientific knowledge including facts and theories is easily acquired from textbooks. The second domain is the variety of methods that scientists use to generate knowledge contained in the first domain. The third domain refers to the legitimisation of the knowledge being generated. Other researchers have also noted similar views about the characteristic features of the nature of science (Akerson, Cullen, & Hanson, 2009; Parkinson, 2004; Wellington, 1998a). Millar (2004) perceived the nature of science as follows;

> It includes an understanding of how scientific enquiry is conducted, of the different kinds of knowledge claims that

> scientists make, of the forms of reasoning that scientists use to link data and explanation, and of the role of the scientific community in checking and scrutinizing knowledge claims as what the nature of science is (p. 1).

Many text books and science teachers use the third domain of the characteristic of science to define what science is (Withely, Miller, Durant, Evans and Thomas as cited in Abd-El-Khalick, 2005; American Association for the Advancement of Science, 1990; Arkansas Science Teachers Association, 2006 ; Flick & Lederman, 2004; Millar & Osborne, 1998). However, the third domain is abstract and is often poorly addressed in many curriculum materials especially in addressing the question on how scientific knowledge is constructed (Bell, 2009).

Construction of scientific knowledge can be done using the scientific method (Mak, Mak, & Mak, 2009). The scientific method includes "making direct observations and experimentations, formulating and testing hypothesis about an aspect of the natural environment" (Flick & Lederman, 2004). However, there is now a growing argument amongst science educators that the scientific method is not the only method to construct scientific knowledge and is misleading (Abd-El-Khalick, Waters, & An-Phong, 2008; Bell, 2004). The misconceptions are often related to the Myth of a single "Scientific Method" and the idea that scientific theories may be promoted into laws when proven (Bell, 2009). Also, it is claimed that Sscientific knowledge is a human construct so is tentative and is modified from time to time, when new observations, tests and explanations have been conducted (Özdemir, 2007). Therefore scientific knowledge is not absolute but can be challenged which is part and partial of the nature of science (Parkinson, 2004; Wellington, 1998a).

Deriving scientific understanding does not always require directly observable phenomena. Scientific knowledge can also be constructed through theorizing and inferring of occurrences based on models and simulations or beliefs and experiences of the natural world (Morris, 2009). That means scientific knowledge can be acquired through making observations and inferences or thinking about the occurrence in nature (Bell, 2008). The second domain of the nature of is not only about knowing the different methods and processes but rather having a clear understanding about why they have to be done (Bell, 2009; Özdemir, 2007). In fact, generating theories and laws consistent with scientific observations is a "hallmark" of science where the evidence from these observations is collected during science investigations (National Science Teachers Association (NSTA), 2007, p. 1). A science investigation can be defined as an experience in the laboratory, classroom, or the field that provides an opportunity to interact directly with natural phenomena (National Science Teachers Association (NSTA), 2007). Therefore, conducting practical science activities should be a core ingredient to the teaching and learning of the nature of science.

2.1.1 Teaching the nature of science

This sub-section aims to shed some light on the important role that science educators and science teachers especially those who teach in secondary schools play to ensure that learners understand the importance of learning science; what scientists do and why it is important to understand the nature of science. Research has shown that many science teachers do not fully understand some aspects of the nature of science (Halai & McNicholl, 2004; İrez & Çakir, 2006; Linneman, Lynch, Kurup, Webb, & Bantwini, 2003; Thye & Kwen, 2003). One of these areas is the understanding of the nature of science. Many countries have now included the nature of science in their science curriculum as they have seen the importance for learners to understand the concept (Halai & McNicholl, 2004). There is a general belief that the state of students' scientific literacy is low in many countries because science teachers are not well versed with what the nature of science is and thus do not include this in their teaching program (Flick & Lederman, 2004). Lineman et al (2003) believe, including it as a strand in the curriculum will ensure that science teachers undertake further training to effectively teach students the nature of science or will oblige them to pay some attention to teaching it as a topic in science. Shah (2009) noted that many science teachers have a very linear view of the nature of science so they only teach their students science content and the way scientists conduct their studies but do not make the link between what science is and the nature of science.

There is agreement in the literature that the value of science encompasses different aspects including, science content, and scientific skills of observing, theorizing, hypothesizing, testing, experimenting and making conclusion or what is regarded as the scientific method as noted earlier (Griffiths, 1995). Deboer (2004) draws attention to the need for science teachers to encourage their students to engage in various science activities that promote scientific inquiry as they are part of the nature of science. He suggests that scientific inquiry may be achieved by adopting some of the teaching strategies like the constructivists approach, inquiry learning or Problem Based Learning (PBL). The nature of these teaching strategies should be student centred where students are encouraged to ask questions and find ways to solve the problems which is what science is. When students have a clear understanding about the relationship between what science is and the nature of science it helps them to make good decisions as to why certain things occur the way they do in nature (Smith & Scharman, 1999).

In fact, this is the view of many science educators in this century for science teachers to be clear in their role to teach what science is, what scientists do and why they study science as this will enable learners to be more scientifically literate (Abd-El-Khalick, Bell, & & Lederman, 1998; American Association for the Advancement of Science, 1993; Rutherford & Ahlgren, 1990). Furthermore, science teachers' should realize that they are vested with the responsibility to teach learners the different nature of science aspects that can be used to understand natural phenomena. These include science contents, scientific processes that scientists use to study science including the scientific method as well as engaging students with various learning strategies including doing practical science activities. Therefore, science teachers have an important role to play in building up students understanding of what science is all about so that students are clear about the role that science play in their everyday lives and become scientifically literate citizens. How effective teaching and learning about science in schools will reflect in how scientifically literate students are when they join the wider community. Many ordinary people do not have a good understanding about what science is including the nature of science (Scotchmoor, Thanukos, & Potter, 2009). Research studies have shown that many people relate science to professions like doctors and engineers but do not have a proper understanding of how science works (Medawar, Russel, & Abdul Kalam, 2002). This is not only evident in western countries but many other developing and the developed countries (Marincola, 2006). This lack of understanding about the nature of science aspects by the public has underpinned the efforts by many countries to focus on science literacy in this century (Medawar et al., 2002; Sturgis & Allum, 2004). Studies conducted in some western countries showed that only a very small proportion of the population could answer factual questions like the earth is round or that working scientifically involves doing experiments (Withely, Miller, Durant, Evans and Thomas as cited in Sturgis & Allum, 2004).

However, there is some evidence of a shift in public perception today as more people now have been able to look at scientists and their work in a much broader perspective. Some people now look at the work of science as a body of knowledge that employs a systematic process in gathering information to better understand issues like climate change and the challenges that HIV AIDS brings to the world (Campbell-Lendruma & Bertollinia, 2010; Jürgens, 2007; Lindzen, 2002). Furthermore, other peoples' perception about science has now shifted to focus more on trying to understand how science gather information to explain the occurrences that happen around them every day. The shift in public perception can be improved even more if schools play an active role through the effective teaching and learning of science. In this way, ordinary people may appreciate more the role that scientist play and also be able to explain why certain occurrences have occurred the way they do.

The next section continues to explore whether carrying out practical science activities by students has any purpose in enhancing students' learning in science.

2.2 Purpose of practical science activities

There are a wide range of purposes for students to be engaged in doing practical science activities. A common view for doing practical science activities if for students to develop cognitive, skill and affective domains (Hodson, 1998; Wellington, 1998b). In addition, there is a strong argument that doing practical activities should focus more on what is to be learned from the activity than just doing the activity (Millar, 2004; Pekmeza, Johnson, & Gott, 2005; Roberts & Gott, 2008). They support students acquiring scientific skills, an understanding of scientific processes; an understanding of scientific concepts and curiosity and motivation to engage with science (Hodson, 2005; Hofstein & Mamlok-Naaman, 2007; Högström, Ottander, & Benckert, 2008; Woodley, 2009).

2.2.1 Skills development

The skills that students can gain in doing practical science activities include process skills, which can be gained through manipulation of science equipment or experimentation (Tifi, Natale, & Lormbadi, 2006). Scientific process skills also include students learning to observe, classify, predict measure, infer and communicate scientifically (Rambuda & Fraser, 2004). These skills are important for students to develop as they are very helpful for gathering scientific data and information to understand the occurrences of events being investigated in a lab or in the natural setting (Johnson, Wardlow, & Franklin, 1997; Richardson et al., 2008). In other words " they represent the foundation of scientific reasoning that learners are required to master before acquiring and mastering the advanced integrated science process skills" (Brotherton & Preece, 1995; Funk, Fiel, Okey, Jaus, & Sprague, 1979, p. 1). It has also been argued that when students get involved in practical work they acquire and develop intellectual skills (Hollingworth & McLoughlin, 2000; Kirschner, 1992).

However, such skills cannot be realized if the aims of the practical activities are not clear and specific to the learner (Hoftsein & Lunetta, 2004; Kapenda et al., 2002; Millar, 2004). Some research studies have reported that although students do a lot of practical science activities they are not told why the skills are important because their science teachers provide little information and guidance on the rational of doing a practical activity (Ango, 2002).

2.2.2 Learning about the scientific method

One of the aims of doing practical work is for students to master how to apply the different aspects of the scientific method (Swain, Monk, & Johnson, 1999). This view is from the perspective that learning science should teach students to think systematically and also encourage them "[to] participate in each step of the scientific inquiry process" (Steel, Kelsey, & Morita, 2004, p. 21) It is argued that some aspects of the scientific method that students should learn in doing practical activities include making scientific observation, asking questions, theorizing and hypothesizing, experimenting analyzing and deducing conclusions (Rothchild, 2006).

However, it is cautioned that science teachers have a clear understanding about the essence of the scientific method when it is taught to students as one of the dangers is when it is implied as "single list of steps or recipe" to generate scientific knowledge (McPherson, 2001, p. 242). Other science educators argue that such skills are not normally achieved by students because science teachers do all the planning and provide all the instructions leaving the students with little to think about or being challenged by to stimulate their learning (Ajaja, 2009; Coughlin & Hannafin, 2003)

2.2.3 Supporting conceptual development

It has been suggested that one of the main purposes of doing practical activities is to enhance students' understanding about scientific concepts (Ghartey-Ampiah, Tufuor, & Gadzekpo, 2004; Paixoa & Cachapuz, 2000). In other words, doing practical science activities may help to reinforce theoretical ideas (Clark, 2008; Foulds & Rowe, 1996; Fullick, 2004; Gatt, 2004). This is significant especially for science concepts that are abstract or difficult to visualize like cells which can only be fully realized by using a microscope (Wallace & Kang, 2004).

However, one of the criticisms of practical work is that it has little effect in enhancing students learning of scientific concepts. This is based on research studies conducted by various researchers including Millar (2004), Hodson (2005) and Hoftsein & Lunetta (2004). In addition some studies concluded that many students concern when doing practical science activities is just for the sake completing that task which is a concern (Hart, Mulhall, Berry, Loughran, & Gunstone, 2000).

2.2.4 Motivation and curiosity

One of the main purposes of doing practical work is to motivate students towards science (Manaf & Subramaniam, 2004). Many students lose interest in science when they enter secondary schools (Brodie, 2006). Doing practical activities may add variety to the different ways of learning science, making it more interesting (Hayward, 2003; Swanson, 2000). It is also suggested for science teachers to select types of practical work that enhances students' motivation towards learning of science (Staver, 2007; Sterling & Frazier, 2008). Modern science teachers need to move away from the old methods of facilitating experimental work using pre-formulated texts, and move towards engaging students with a lot of hands on activities where students become motivated, interested as well as having fun (Roscorla, 2009; Yagenska, 2007).

However, as already noted practical activities with no real purpose have little value to students learning (Byers, 2002; Eberbach & Crowley, 2009). In addition it is believed that science teachers should continue to be innovative in their outlook to design practical activities that motivate students at the same time do not divert the focus of learning science (Moore, 2003).

The next section continues to explore the different practical science activities.

2.3 Practical science activities in secondary schools

This section of the review will attempt to provide an explanation of what a practical science activity is. A practical science activity or what is sometimes termed as practical work in secondary schools is usually a synonym for doing laboratory work using science equipment. It is argued that the use of the term practical work is misleading as it does not consider other designed activities that can be done outside the lab or use of other mediums (Hofstein & Mamlok-Naaman, 2007). There are wide range practical science activities. Brown (1995 as cited in Kapenda et al., 2002, p. 54) noted that some of the practical science activities that can be done in secondary schools may include "[classroom] exercises to develop specific skills such as hypothesis testing or problem solving; teachers using experiments to introduce phenomena; demonstrations or create a dramatic impression; and fieldwork".

2.3.1 Designed activities or exercises

Practical science activities are not limited to laboratory work but may include teacher designed activities. A worksheet that a science teacher designs for students to be engaged in either as a form of group work or as individuals may be regarded as a practical science activity. Another designed task may be a library exercise that students are given the opportunity to find out for themselves information about a particular topic. In trying to define what a practical science activity is, many science educators agree that simple classroom exercises as described above falls under the definition of a practical science activity as it help students to think critically about how to solve problems (Heckert, 2007; Ngozi ibe, 2009; Waldrip, Prain, & Carolan, 2006). In other words cognitive skills or thinking skills are being developed when students are given such activities. On the whole an exercise whether it be conversation based or a classroom task or library research or others can be defined as a practical science activity.

However, teachers have to be very clear about what a practical science activity is in order to design useful activities for their students. Some science educators believe that such understanding are only acquired after gaining experience in teaching science and being able to evaluate their own strengths and weaknesses (Aitken, 2008; Carboon, 2009).

2.3.2 Science investigations to test for hypothesis

A practical science activity may be perceived as an investigation that is carried out that involves testing of a hypothesis or solving a problem (Hofstein & Mamlok-Naaman, 2007). Testing a hypothesis may involve hands on activities in the laboratory or in the field including making observations and collecting data to be able to make generalizations (Bradley, 1999; Burke da Silva, Auburn, Hunter, & Young, 2008; Högström, Ottander, & Benckert, 2009). Investigating, testing and making observations fits very well with the definition of what a practical science activity is. Testing a hypothesis is in fact part of the scientific method that scientists adopt in trying to verify claims and solve problems (Gauch, 2003). It has been asserted that students should be encouraged to do practical science activities as it helps them to develop their skills in working scientifically (Hamilton & Swortzel, 2007; Wallace & Kang, 2004). It also allows students to master the skill of making scientific observations and making scientific conclusions based on evidence which is the essence of the work of science.

However, it has been argued that science teachers have to be well versed with such practical activities to effectively help their students appreciate the importance of gaining such skills (McLoughlan, 2007). Some science educators believe that there needs to be a reform in the science curriculum to accommodate new changes that focus on encouraging students to engage more on activities that involve a lot of inquiry and problem solving (Dawes & Rasmussen, 2006; Kidman, 2008). In this way they will learn to think systematically and use logic to solve problems.

2.3.3 Experiments

It is considered that doing experiments is the hallmark of what a practical science activity is as they usually relate to the actual manipulation of resources (Tifi, Natale, & Lombardi, 2006). Experiments can be part of classroom work designed by teachers or through student initiatives. Engaging students in experiments or hands own activities may help students to construct scientific knowledge especially through manipulation of resources like models and equipment (Lee, 2007; Sandoval, 2003). When students conduct experiments they can gain a variety of skills including observation skills; thinking skills, computing skills, writing and recording skills. Carrying out experiments can also motivate students as they may be given the opportunity to do their own investigation.

However, some people view experiments as activities that are only conducted by scientists in a science laboratory (Bryant, 2009). It is claimed that many science teachers do experiments that are extracted from text books or from lab manuals which in many cases are used by students as recipes and do not allow them to think (Clark, 2008). Other research studies concluded that students only do the activities for the sake of completing the tasks but with no purpose (Hart, Mulhal, Berry, Loughran, & Gunstone, 2000).

2.3.4 Teacher demonstrations

Demonstrations are a form of practical science activity that science teachers can plan for their students (Woodley, 2009). Some science educators have suggested that demonstrations can be categorized into different categories which include "visual aids using non-conventional apparatus, analogue demonstrations and real experiments" (Erlis & Subramaniam, 2004, p. 1). Demonstrations as a form of practical activity can benefit students in many ways including encouraging learner inclusiveness and student centered inquiry learning (Beasley, 1982; Buncick, Betts, & Horgan, 2001; Meyer, Schmidt, Nozawa, & Paneee, 2003). Demonstrations can be an important and effective form of practical science activity in situations where science resources are scarce or when class sizes are too large (Hayward, 2003; Ruehr & Orr, 2002).

However, other science educators argue that demonstrations are just a waste of time and resources because students are not actively engaged in actual manipulations and hands on activities (Swanson, 2000).

2.3.5 Field -work or outdoor practical activities

Field work may consist of range of activities such as observations of natural phenomena like plants and animals in a forest, visiting a park or zoo (Eberbach & Crowley, 2009; Tunnicliffe, 2000). The importance of this type of practical activity is that it enables students to have a wider perspective about the nature of practical science activities and that they are not limited to laboratory organized tasks. The other advantage of conducting outdoor practical activities is that it allows students to actively engage in making observations, thinking process, organizing and managing the whole practical active (Abrahamsa & Millar, 2008). Field-work can also motivate students especially when they investigate live specimens including plants and animals and when they are actively involved in making observations.

However, some science educators cautioned that such activities have to be properly planned, monitored and supervised to ensure that the activities fulfill their aims and objectives (Powera, Taylora, Reesa, & Jonesb, 2009). The next section explores the factors influencing the decisions of science teachers to include practical science activities and differences between rural and urban secondary schools.

2.4 Factors influencing teachers' decisions to include practical science activities and the differences between rural and urban schools

This section will look at the opportunities and constraints that science teachers encounter in organizing and planning for practical science activities. Some of these factors include; science syllabus, teacher training, experience/length of time in teaching, inter-school support, resources, time and class size. These same factors also differentiate rural schools from urban schools.

2.4.1 Science syllabus

The science syllabus plays an important role on what teachers plan for their students' learning including practical science activities (Monkman, 2001; Siddique, 2008). In acknowledgement of that and to accommodate new thinking and change curriculum reforms are part of the 21st century in many countries (Cheng, 2001; Park, 2006; Schank, Krajcik, & Yunker, 2007). The need for change has been driven by two main issues: first, the need to increase the numbers of scientists and second the need to have scientifically literate citizens (Siddique, 2008). This means that science syllabi have to place more emphasis in developing students' inquiry skills to gather and process information than learning science contents (de Feiter & Ncube, 1999). Assessment requirements also contribute to types of practical tasks science teachers plan and organize for their students (Cavanagh, Waldrip, Romanoski, Dorman, & Fisher, 2005; Harlen, 2005).

However, it is asserted that the implementation of any science syllabus lies in the hands of the science teachers whether they have necessary knowledge and skills to translate the objectives especially in planning and organizing practical science activities (Ajaja, 2009). Such knowledge and skills also reflect the training teachers have received.

2.4.2 Training and practical knowledge

Teacher training is important to enhance quality teaching and learning in science including planning and organizing practical science activities in secondary schools (Bekalo & Welford, 1999; Mji & Makgato, 2006). Teacher's understanding of content knowledge is an important ingredient in planning practical work for students (Klafki, 2000). Teachers who undertake training (content or pedagogy) in science whether it is pre-service or in-service often benefit from this experience in the way they plan or organize practical science activities for their students (Nivalainen, Asikainen, Sormunen, & Hirvonen, 2010). Research suggests that older science teachers lack at times training especially around changes in science syllabi (Ivarsson-Jansson, Cooper, Augusén, & Frykland, 2009). Teachers with no formal science qualifications who are hired to teach science due to shortage of trained science teachers need particular support to increase their knowledge about science and teaching (Zakaria & Daud, 2009). In-service science teachers often benefit from a focus on pedagogy or specific content areas where they lack background knowledge (Hawley, 1990; Oscarsson, Jidesjo, Stromdahl, & Karlsson, 2009; Zeichner & Schulte, 2001). At times science teachers also feel inadequately prepared in their pre-service training for the challenges of planning practical work (Bekalo & Welford, 1999). Therefore, training that address specific areas of need teachers have seems to be important.

2.4.3 Teacher experience and support

There are different ways in which the experiences of teachers can be gauged. One way as often suggested is by looking at teachers' pedagogical content knowledge (PCK) that teachers acquire through the process of teaching (Leea & Luftb, 2008).An aspect of PCK that science teachers gain over time is related to determination of the best ways to facilitate appropriate science lessons including practical science activities for their students (Lee, Brown, Luft, & Roehrig, 2007) Research conducted in some countries has shown that science teachers who have taught for more than six years score higher in their recall of content knowledge than new science teachers (Prakash & Uddin, 1990). Science teachers who become well versed with a particular knowledge base are referred to as “highly accomplished teachers “(Denly, 2007, p. 10). Other science educators believe that science teachers who are posted to schools or environments that are not similar to theirs must be treated as beginning teachers therefore will require some induction to familiarize themselves to the new school culture (Luft & Roehrig, 2005).

However, research has noted that some teachers might have a lot of experience about a content knowledge or are highly accomplished teachers but sometimes do not use this knowledge effectively to enhance their students’ learning (Denly, 2007). It has been noted that science teachers have to take other factors into consideration like school context to effectively plan or organize practical science activities for their students (Lankford, 2010).

Science teachers who receive support from their schools are often more enthusiastic about their job (Melville & Yaxley, 2009; Sterling & Frazier, 2008). This enthusiasm depends also on the support teachers receive from their leadership. Research has argued that more science teachers leave the teaching profession early compared to other teachers from other subject areas due to lack of support received from their school principals or head of science department (Ingersoll, 2000; National Science Teachers Association, 2000). Melville and Yaxley (2009) propose that school support may include organizing a more experienced teacher to be a mentor in support of collaborative teaching and planning of classroom activities including practical work.

However, some problems that science teachers encounter are not necessarily due to lack of inter-school support but due to hiring of untrained science teachers who have inadequate knowledge and experience to teach science (Jacobs & Kritsonis, 2006). This is an issue for Solomon Islands where teachers need to be recruited at times without this crucial background because of understaffing.

2.4.4 Time

Time as a factor that impacts on teaching and learning has been considered only recently (Roth, Tobin, & Ritchie, 2008). It has been asserted that time to do activities can be influenced by factors like unplanned school breaks and other extra curricula activities that contribute to loss of time to complete the requirements of the science syllabus (Chisholma, Leyendecker, Chisholma, & Leyendecker, 2008; Mji & Makgato, 2006). Assessment requirements also determine the time that is available for doing practical science activities and the types of practical science activity to be conducted. It is also claimed that School Principals sometimes pressure their teachers to spend more time on tasks that can be assessed for reporting students end of term grades than on other things (Marsh, 2007).

However, giving more time to students to determine their own learning by doing practical science activities could maximize students learning. Research suggests that science teachers should focus on practical science activities that encourage students to be engaged in inquiry learning where time is not the determining factor but students understanding (Balım, 2009; Bravo et al., 2008; Brickman, Gormally, Armstrong, & Hallar, 2009; Bryant, 2009; Burke da Silva et al., 2008). The essence of promoting such activities means that students are encouraged to find solutions to problems, which is the basis of how science works.

2.4.5 Resources

The availability of science resources can impact on teachers conducting practical science activities with their students (Mji & Makgato, 2006; The Save British Science Society, 2004). It is claimed that science teachers in some countries won't do practical science lessons because they do not have the necessary science equipment (The Save British Science Society, 2004, p. 6). This claim is supported by other studies, however what is understood to be a resource can vary (Musar, 1993). Resources may include a science laboratory, science equipment, science text books or other materials that would be useful to facilitate practical science activities (Onwu, 1999).

However, there is strong argument amongst science educators that doing practical science activities can still be achieved as practical work is not only limited to laboratory work but can include opportunities outside the usual laboratory setting

(Hofstein & Mamlok-Naaman, 2007; Ndirangua, Kathurib, & Mungaib, 2003; Waldrip et al., 2006; Woodley, 2009).

2.4.6 Class size

Class size can become an issue when practical science activities are conducted in a science lab or classroom where space and resources determine the number of students (Centra, 2009; Conoley & Hildick, 2007). Studies on class size on other aspects of science teaching and learning have shown a corresponding relationship between students' achievement and class size where a small class size has a higher rating (Çakmak, 2009). Class sizes are determined by various factors including the age of students (Goldstein & Blatchford, 1998). In many countries, the optimum number of students at junior secondary level that space in the classroom can accommodate with the age group around 14 years of age is 25 (Toner, 2004). Class size also impacts on science teachers' teaching strategies for example whether to do tasks in small groups or to resort to other activities class size becomes a non-issue(Capel, Leask & Turner, 1995 as cited in Çakmak, 2009).

However, it is generally agreed that class size is not a big concern when doing practical science activities outside or during field studies (Lock, 1998). Visiting museums and field visits can be regarded as practical science activities where class size is not an issue as everyone can go together or even in small groups alike without any difficulties (Tunnicliffe, 2000). Likewise walking through a forest; making direct observations of natural environment like a stream or patch of grass does not require much concern about class size (Ng & Nguyen, 2006). As such the issues of class size vary depending on the type of activity that is intended to be done and where the activity is to be conducted.

2.4.7 Location of the school

School location is noted as one of factors that differentiates rural secondary schools to their urban counterparts. In many western countries, school location have an impact to teaching and learning especially with lack of technology like computers to access information from the internet (Lawless, 2009a). In today's world access to a computer is vital to access information including activities related to doing practical investigations like doing a literature research. Urban secondary schools are advantaged in terms of location as they are close to different avenues where teachers can source information, for example from internet facilities, libraries and other medium of learning to assist them in their planning of practical science for their students (Eminah, 2004). It is claimed that transporting supplies to schools like books is sometimes difficult for rural secondary schools as access to rural schools are sometimes none (Bouck, 2004). And this is particularly the case in Solomon Islands. Other factors that differentiate rural secondary schools from urban secondary schools as an effect of location also include, class size, teacher training and support and time (Prakash & Uddin, 1990; Roth et al., 2008; Toner, 2004)

However, some countries have considered other options like using TV based educational programs by installing television in the rural areas to do studies (Castro, Wolff, & García, 1999).

2.5 Summary

This chapter presented the literature review. The literature suggests that understanding what science is, the nature of science, is important in the teaching and learning of science. It has been discussed what the nature of science is and what it means in respect to practical activities and the role teachers play when they are teaching practical science activities as an aspect of the nature of science.

Section 2.2 explored the purpose of doing practical science activities. The literature suggests that there is a wide range of purposes for doing practical science activities including supporting conceptual development, skill development and motivation. Section 2.3 reports about practical science activities in secondary schools. The literature review looked at factors that influence science teachers' planning and designing of practical science activities for their students including the science syllabus, training and knowledge about practical science activities, time resources and class size. The chapter also discussed how the location of a school may impact on teachers conducting practical science activities.

On the basis of what the literature suggests this research set out to investigate:

- What are F2 urban and rural Solomon Islands secondary science teachers' perceptions about the purpose of practical science activities?
- What do those teachers report about their experiences in carrying out practical science activities?
- Are there differences between urban and rural schools?

The next chapter will discuss the methodology and methods utilized to explore these questions.

Chapter Three: Research design and Methodology

3 Introduction

This chapter describes the methodological approach adopted in this research and the methods applied. The chapter will begin with the theoretical framework that encompasses or determines the choice of research paradigm used in this study. This is followed by a full description of the characteristics of qualitative inquiry. The chapter will also describe the qualitative research approach used in investigating four cases of teachers' reports. This will then be followed by the methods used to collect data and ethical considerations. Then the data analysis using the grounded theory approach will be discussed followed by a discussion of issues around the reliability and validity of the study.

3.1 Theoretical Framework

Social science and educational research methodology is typically organized into two research paradigms: positivist and interpretive. The underpinning factor that influences the type of paradigm lies on the assumptions about reality, knowledge and human nature (Cohen, Manion, & Morrison, 2007; Creswell, 2005; Mackenzie & Knipe, 2006). A paradigm is a world view which is shared by a community of researchers (Voce, 2004). The interpretive paradigm is underpinned by the assumption that reality of knowledge can be constructed by the researcher and, as such, is inseparable from the researcher; in the positivist paradigm, in contrast, reality is separated from the researcher (Creswell, 1994; silverman, 1997; Weber, 2004). It is important for researchers to be clear about the type of paradigm they intend to adopt as it will influence the type of data that will be collected and collated.

In this section an explanation of why the interpretive paradigm was appropriate for this research will be discussed. To do this, a description of the positivist paradigm will be provided first.

3.1.1 Positivist paradigm

The positivist paradigm has its own characteristic ontology of realism. The positivist assumption is that the researcher is separate from reality and the two are independent of each other (Weber, 2004). In this model, the researcher searches for the truth which is out there to be discovered by observing and measuring independent facts and employing methods that are typically scientific or experimental, manipulative and empirical in nature (Guba & Lincoln, 1994). The positivist paradigm is typically used when data is quantifiable and can be used to generate general laws, test a hypothesis and make predictions (Broom & Willis, 2007; Maimbo, 2004). In other words, the characteristic feature of this paradigm is that the researcher follows an objectivist epistemology which portrays a linear relationship or one way mirror analogy (Guba & Lincoln, 1994). The positivist paradigm applies the reasoning of cause and effect (Krauss, 2005).

When the positivist paradigm is applied to the study of human behavior, it may produce some very interesting consequences. One of these is the difficulty to objectively observe human behavior and deduce generalizations as what can be done with objects (Buchaman, 1998). Also, when studying human behavior, it is important to consider both external and internal influences that may contribute to why certain behavior is seen to be expressed. For this reason, researchers who adopt a positivist paradigm need to look for ways that objectively measure human behavior to look beyond the subjective meanings which people normally attach to their own behaviors so that they can discover a truer and more essential explanation for those behaviors (Maimbo, 2004). So the positivist paradigm adopts a position where the interpretation within the research is screened out, this can only be achieved when data collected and collated are measureable and empirical in nature.

3.1.2 Interpretive paradigm

The interpretive paradigm, in contrast, aims to seek an understanding of the subjective world of human experience (Cohen et al., 2007). The underpinning goal of the interpretive research paradigm is to understand the participants' views of reality (Lather, 1992). The interpretative paradigm does not look for generalizations and assumptions or objectivity in its outlook but rather looks at interpretations of what is being heard, observed or felt about human behaviors, and it is subjective in its outlook. In other words, the interpretive research paradigm interprets the human behavior as it is displayed in the study (Banister, Burman, Parker, Taylor, & Tindall, 1994). The interpretive paradigm holds the view that there are multiple truths to occurrences being studied so that what is interpreted by a research is what is being heard, observed and being experienced by the researcher (Giorgi, 1997; Husen, 1999). For the interpretive paradigm, it is vital to view what is being studied in its context rather than just looking at one portion of the phenomenon using empirical measurements and assumptions (Krauss, 2005). The essence of deploying the interpretive paradigm is its allowance for the researcher to be able to interpret the views, voices and feelings of participants on why certain things occur the way they do rather than just looking for general overview based on empirical data.

This study is interested in the perceptions of science teachers of the purpose of doing practical science activities and, as these views are shaped by their experiences, the interpretive paradigm is seen to be the most appropriate methodological framework. The interpretive research paradigm allows the presentation of the richness of the data with in-depth descriptions and explanations embedded in the context of the intended study and the participants (Cohen et al., 2007; Creswell, 2005; Mackenzie & Knipe, 2006). It also allows reporting and reflecting on the views and the voices of participants which are subjective and reflect multiple realities. The choice of a small sample of participants fits with the interpretive paradigm (Coll & Chapman, 2000). Therefore, for this study, the interpretive paradigm provides a way to explore how science teachers carry out practical science activities. The methods deployed were qualitative in nature. The descriptions of characteristics of qualitative methods will be discussed in the next section.

3.2 Qualitative research inquiry

A qualitative research inquiry is a research process that is concerned with acquiring deep descriptions of social life of particular settings, events and scenarios (Holliday, 2007). Qualitative research inquiry has been widely used in the social sciences and other disciplines, including education (Marshall & Rossman, 2006). A characteristic feature of qualitative research is that data collected is more verbal and visual in nature than numeric (Devetak, Glažar, & Vogrinc, 2010). Qualitative research inquiry can be viewed from three theoretical perspectives in terms of understanding (interpretive), emancipation (critical and Feminist are included here), and deconstruction (postmodern) (Merriam, 2002). Within qualitative research inquiry there are many research methods that can be adopted to collect data which include both qualitative and quantitative methods. This study used semi-structured interviews and photo elicitation (Cassel & Symons, 1994; Power, 2002a; Shaw, 2009). The essence of adopting semi-structured interviews and photo elicitation in this research study is that the researcher can collect and collate data from the participants in their own natural settings (Power, 2002b). In addition, it allows the researcher to experience and understand the participants' views when they explain issues in their own context (Savenye & Robinson, 2004).

The choice of data collection methods also determines the extent of the richness of the data. In this case, semi-structured interviews and photo elicitation have been chosen. The flexibility of the semi-structured interviews makes it appropriate to satisfy the richness of qualitative data (Horton, Macve, & Struyven, 2004). Furthermore, the use of photo elicitation also increases the richness of the data as participants can use the images to tell their stories more profoundly (Harper, 2002; Van Auken, Svein, & Susan, 2010). The methods that were employed are further discussed in the next few sections.

3.3 Semi-structured interviews

Interviewing is a process of guided conversation and provides a good way to access rich data from a participant (Clifton & Handy, 2001; Thomas, 2002). There are different types of interview methods: structured, semi-structured and non-structured (Cohen et al., 2007). The structured interview is a type of interview process that has a characteristic feature of being rigid as well as having standardized questions with the aim to ensure that the respondents provide very specific answers (Corbetta, 2003; Gray, 2004). Semi-structured interviews are non-standardised and the questions asked can be in any order, unlike in structured interviews, and the researcher can probe further for answers without putting pressure on the participant (David & Sutton, 2004). Unstructured interviews are non-directed and flexible, giving participants the freedom to express themselves (Gray, 2004).

This study adopted semi-structured interviews to collect and collate data as this method is not too rigid as well as not very open, allowing the researcher and the participants be able to compromise with views being explored (Boyce & Neale, 2006). Another reason for the choice of the use of semi-structured interview as a technique or data collection method is because it can be done on a face-to-face or one-to-one basis and it is flexible (Horton et al., 2004 ; Opdenakker, 2006). This method is flexible because it allows the researcher to probe into possibility of further questioning the participant to explain in detail particular comments being made. This technique of data collection is appropriate in the context of the Solomon Islands as people traditionally feel comfortable with storytelling in a relaxed atmosphere. Secondly, semi-structured interviews are appropriate as the interviews allow the researcher to collect real life experiences that satisfy the requirements of the interpretative paradigm (Horton et al., 2004 ; Kimbrough, Davis, & Wickersham, 2008).

3.3.1 Limitations of semi-structured interviews

Limitations to the semi-structured interview may include being time consuming, especially during transcription and analysis of data (Davis, 2001). Semi-structured interviews may also have negative impacts on the participants, especially when the questions are too deep or when the interviewee is reluctant to respond to a question, which may result in the interviewee using avoidance techniques which can be a setback for the interviewer (Cohen et al., 2007). However, in this study semi-structured interviews were framed and conducted in a way that ethical issues were considered such that the participants had the right not to answer any question that they felt was inappropriate.

3.4 Photo elicitation

Photo elicitation has been used in qualitative research since the 1950s (Shaw, 2009). It is a qualitative data collection technique using photographs or images in support to gather information (Epstein, Stevens, McKeever, & Baruche, 2006; Harper, 2002). Photo elicitation describes the use of photographs or images provided by the participants or the researcher to provide deep understandings of perspectives and experiences of people (Crilly, Blackwell, & Clarkson, 2006; Loeffler, 2004). Mitchell (2008) explained that one of the ways photographs can be used to generate qualitative data is for the participant to take charge of an interview session providing explanations about the photographic images and reasons for taking the photographs. The technique of photo elicitation to aid interviewing has been used in various academic disciplines including anthropology, sociology and communications and has been successful as a data gathering method (Douglas 1996 as cited in Shaw, 2009). The photo elicitation process is an appropriate method, as the participants can use the photographs to re-emphasise issues of concern during an interview (Kimbrough et al., 2008). Moreover, photo elicitation is appropriate along with semi-structured interviews, as the participants have the autonomy to create their own stories (Ramella & Olmos, 2005). Photo elicitation makes it possible to extract abstract information that might be difficult to explain in a structured interview (Bryman, 2008). Other advantages of photo elicitation is it provides concrete evidence of what is being investigated and it is like a bridge between the researcher and the participants (Samuels, 2004). This research study deployed what is called auto-driven photo elicitation where the interviewee (participant) decides on the type of photograph taken for interviews (Shaw, 2009). Auto-driven photo elicitation adds to the richness of the data by allowing participants to take charge of the whole process of taking and selecting photographs and providing explanations about the significance of the photographs during the interview process (Shaw, 2009).

3.4.1 Limitations of photo elicitation

The limitations to auto-driven photo elicitation may arise due to selection and subjective nature of images and the participants' ability to take the photographs (Shaw, 2009). In other words, the camera may not work or the participant may not know how to use the camera. Despite the limitations as noted, this research study deployed the auto-driven photo elicitation process because the data collected and collated portray entirely views of the participants. The next sub-section will discuss the ethical issues underpinning this research study.

3.5 Ethical Considerations

Ethical considerations are an important part of doing research that involves humans (Tooth, Lutfiyya, & Sokal, 2007).The essence of this is for researchers to ensure that rights of humans are respected during the course of conducting research (De Luca, 2009; Tooth et al., 2007). Ethical issues need to be considered to maintain the integrity of the research and to guide how the researcher behaves with the participants during the course of the study (Stutchbury & Fox, 2009). Some of the ethical issues that are normally considered during conducting research undertakings include "safety (balancing harms and benefits, minimizing harm, maximizing Benefit), privacy and confidentiality (respect for human dignity, respect for vulnerable persons), honesty (respect for free and informed Consent) and reporting back (respect for justice and inclusiveness)" (De Luca, 2009; Stutchbury & Fox, 2009; Tooth et al., 2007, p. 2). For safety, the researcher has to ensure that causing harm to participants of any sort, including emotional or physical harm, is minimized. The researcher must also ensure that the privacy of both participants and the research study are protected through upholding a high level of confidentiality. Researchers should also uphold a high level of honesty in seeking of participants' consent prior to reporting of findings as a form of respect to both the participants and the research.

While respect for human rights is a universal undertaking to consider when conducting educational research studies, every institution has their own set of guidelines to follow. In this research, informed consent was sought from school principals and the four participant teachers. The identities of participants and their school are not revealed in this research, including in the transcribed raw data used to compile this thesis.

3.6 Data Analysis

The data were analyzed using a grounded theory method (Cohen et al., 2007). Grounded theory can be used to analyze data and identify information that can be grouped or categorized and may lead to the formation of a certain theory (Scott, 2004). This method of analyzing data is applicable to this research study as data collected derived from the five semi-structured interview questions could be compared (Chiovittim & Piran, 2003; Strauss & Corbin, 1994). Grounded theory allows maintaining the voices of the participants while comparative analysis is conducted (Strauss & Corbin, 1990). Using a grounded theory method, the researcher goes through the data looking for similarities and differences and putting them into different categories. This process usually involves three stages (Mavetera & Kroeze, 2009):

> Open coding - where the researcher begins to segment or divide the data into similar groupings and forms preliminary categories of information about the phenomenon being examined.
> Axial coding - following intensive open coding, the researcher begins to bring together the categories he or she has identified into groupings.
> These groupings resemble themes and are generally new ways of seeing and understanding the phenomenon under study.
> Selective coding - the researcher organizes and integrates the categories and themes in a way that articulates a coherent understanding of theory of the phenomenon of study (p. 15).

The different coding processes noted above are done simultaneously so that a progressive theory is built as the study proceeds (Dick, 2003). Scott (2004) highlighted that the essence of grounded theory is that a theory is developed through the findings of the study and also when the study involves comparing two variables. The other characteristic of the grounded theory is that the researcher cannot identify in advance the various categories that may arise in the study (Gorlenko, 2006). For this research, the grounded theory approach has been adopted to allow the teachers' voices to be preserved and inform emerging themes. This study was also concerned to assure reliability and validity of the findings which will be discussed next.

3.7 Reliability and Validity

Reliability and validity are two terms that are commonly used in quantitative research to measure consistency and truthfulness of research findings respectively (Bashir, Afzal, & Azeem, 2008; Golafshani, 2003). In qualitative enquiries, reliability and validity have their own merit to determine and ensure rigor of the research undertakings (Healy & Perry, 2000).

3.7.1 Reliability

Reliability can be defined as how accurate a measuring instrument is over a period of time or the consistency of any measurement (Rambaree, 2007). However, it is argued that the concept of reliability in qualitative research can be misleading as it is not the same as how reliability is defined under quantitative research (Morse, Mayan, Olson, & Spiers, 2002). In quantitative research, reliability of the research study can be easily verified provided that the same variables are applied when a similar study is conducted at another time (Sharma, 2010). However, in qualitative research reliability refers to dependability, which can mean how two different researchers produce results studying the same context involving the same participants (Erlandson, Harris, Skipper, & Allen, 1993). In this study, the reliability of the data collected was maintained in several ways. First, through the use of the same guiding questions for the four participants to answer during the interviews maintained a consistency on the type of data collected. This strategy to maintain consistency is what some researchers believe can be done to achieve reliability (Ratcliff, 1995). Secondly, reliability of the data was further strengthened by transcribing interviews and returning the transcripts to the participants for checking. This strategy of trying to attain reliability is in line with what some researchers suggest (Perakyla, 1997; Roberts, 1999). The first strategy is to ensure that the participant's voice is accurately recorded during transcribing of the data by recording word for word then followed by returning the transcribed data to the participant to recheck for accuracy of the records. Furthermore, reliability was strengthened through the coding of the data during data analysis (grounded theory) to arrive at the different themes (Roberts, Priest, & Traynor, 2006). Achieving reliability in applying the different coding is when the researcher goes through line by line checking for similarities or differences without distorting the actual words used by the participants (Mavetera & Kroeze, 2009). The next sub-section will discuss how validity can be attained in qualitative research and the approach that has been taken in this research.

3.7.2 Validity

Validity is concerned with how accurate or truthful the recorded features of a phenomenon is (Rambaree, 2007). In this research study, validity has been achieved through the triangulation of method of data collection, by conducting the first round of interviews using questions, and then second round of interviews using photo elicitation method. Triangulation has been widely adopted in many qualitative research undertakings to attain validity (Lewis, 2009; Schwandt, 1997). Validity of the data was also attained by allowing the participants to recheck the transcribed interviews so that participants confirmed that what was transcribed was exactly what were said by the participants. This is a strategy that has been widely adopted by many researchers (Johnson, 1997; Mays & Pope, 1995). However, some researchers do not favor such strategy, as the participants may have a different agenda and perspective to the intentions of the researcher (Barbour, 2001; Horsburgh, 2003). Nevertheless, data collected from individuals have to be validated by the participants so that any issues of concern can be discussed more openly to bring about stability (Long & Johnson, 2000). Deploying the grounded theory to analyze the data collected also contributes to the validity of the research findings of this research study (Parry, 1998).

3.8 Summary

This chapter has presented the methodological approach and methods applied in this research study. The chapter began with the theoretical framework that this research study adopted, which was the interpretive paradigm. This chapter continued to explain that this project employed a qualitative inquiry using semi-structured interviews and photo elicitation interviews. The discussion of these methods included drawing attention to the limitations of both data collection methods. The chapter also explained why ethical considerations needed to be taken care of and how this was achieved. To analyze the data that was collected, this research adopted the grounded theory approach. The final part of this chapter deliberated on how reliability and validity was achieved. The next chapter will present the results from the data collection.

Chapter Four: Data analysis

4 Introduction

This chapter presents the results of the data collection and analysis of the findings. The first section describes the background and the data collection process at each school including some description about the planning and logistics involved in facilitating the actual school visits. The second section focuses on the interview data collected from the teachers during phase one followed by each participant's photo elicitation. Each teacher's story is presented with their chosen photographs. The chapter then presents the themes between the teacher's experiences identified from phase 1 and 2 to describe the commonalities and differences and respond to the three research questions that this research study set out to answer. The chapter concludes with a summary.

4.1 Participant profile, background of schools and data collection procedures

The participants who were invited to participate in this research were from four Solomon Island secondary schools, two from urban areas and two from rural areas. The teacher participants had been teaching in the schools one or more years and all were teaching Form 2 science. For this research study the two rural schools were from Santa Isabel, one of the Provinces in Solomon Islands, and the two urban schools were in Honiara, the capital of Solomon Islands on Guadalcanal. The two rural secondary schools were boarding schools about 30 to 40km from each other. These schools can only be accessed by outboard motor (OBM) or by ship and the only form of communication is by surface mail or wireless radio. More information about the schools is presented in section 4.3.

Collection and collation of data was conducted in two phases. First, the four science teachers were involved in individual semi-structured interviews. The duration of each semi-structured interview was approximately 40 to 50 minutes. The interview questions were given to the teachers prior to their actual interview schedule. Arrangements were made with each teacher participant prior to their interview sessions to identify times that were convenient to them. Also permission was sought from each teacher participant to audio record their interview using a digital voice recorder. The interviews were transcribed and given back to them for verification.

The second phase of the research involved the teachers taking photos of examples of practical science activities they normally use. The teachers were asked to take photos of resources and settings but not of students or other teachers. The participants were then asked to provide a commentary about the photos they took in a second round of semi-structured interviews. The participants' stories were audio recorded, transcribed and given back to them for verifications and annotations. Each school visit took about a week. The schedule followed in the process to engage the teacher participants is as outlined;

Day 1. On site briefing with school principal and teacher participant.

Day 2. Semi-structured interviews with participants which were audio recorded (40 to 50 minutes).

Day 3. Teacher participants received transcripts and were given the opportunity to edit transcript.

Day 4. Teachers took photos, uploaded images and were involved in a teacher/researcher second round of semi-structured interviews.

Day 5. Teacher participants received a transcript of their photo story for review and given an opportunity to edit this.

4.2 Descriptions of phase 1-Interviews

This section describes the interview conversations between the researcher and the four science teachers about the research study and how the teachers will be involved in the research process. The descriptions are based on the five interview questions that the researcher asked each of the teachers during each school visit. The five interview questions were;

1. Tell me about your favourite practical science activities you like doing with your students?
2. Tell me about what purpose do you see in conducting practical science activities?

3. Tell me about how the syllabus influences you in planning and organizing practical activities for your students?
4. Tell me about what works well and what doesn't work well when you plan or organize practical activities for your students?
5. How do you assess your students when they are doing practical science activities?

The science teachers and their secondary schools were given pseudonyms. Nokonaota was from the first rural school called Greybeach, Kakadolo was from the second rural school called Sandfly, Lole was from the first urban school called Farwest and Niksen was from the second urban school called Hopeful. The answers provided by the science teachers for each question are as described under each question.

4.2.1 Favourite practical science activities

The four science teachers expressed that they had different favorite practical science activities that they normally plan and design for their students. Nokonaota explained that his favorite practical science activities were those related to Biology like studying plant cells although he did not say why he was interested specifically in Biology. However, he did note that students should do practical work as science involves both theory and practical work which work hand in hand. Kakakdolo's favorite practical science activities were those related to physics and electronics. He believed his students are weak in these areas as the concepts are quite abstract and needed to be clarified by doing more practical science activities. However, he expressed concern that he could not achieve this.

> Kakakdolo: ...probable reason is due to lack of equipment to carry out practical activities in terms of electronics...

Kakadolo further expressed that the rate at which technology is advancing today is fast therefore it is important that students' learning must also keep up with new technology.

In contrast, Lole and Niksen from the two urban secondary schools noted that the practical science activities they planned for their students are those prescribed in the science syllabus. Lole explained that some of the practical science activities he normally did with his students included acid base reactions, testing alkalinity and acidity of substances, testing for voltage and currents of parallel and series circuits and chemical reactions. Lole's reason why he liked the practical activities noted above were related to the access of science equipment and resources.

> Lole: ...why I like these practical activities are because the equipments or resources to carry out such activities are available in the lab...

Lole expressed that having the resources and science equipment available in the school has been very helpful as time is limited for planning and organizing practical science activities. He explained that day school programs are very tight as they have to complete both classroom and extra-curricula activities within the official hours between 8.00am and 4.00pm unlike in boarding schools. Niksen highlighted similar practical science activities which require the use of science equipment that can be used in a science lab including beakers, test tubes and Bunsen burners.

Interestingly, the four science teachers had different perceptions about what practical science activities are. Nokonaota believed that practical science activities are those activities that are "hands on" and can be done in a science classroom or out in the field such as classroom exercises, library research and field work. Kakadolo considered that in science practical science activities are almost any activities that allow students to use their senses (hear, see, touch, taste.. etc) to think logically, make observations and provide an explanation about an occurrence or event. Niksen saw practical science activities as involving manipulation of science equipment or materials.

4.2.2 Purpose for conducting practical science activities

The four science teachers expressed a wide range of views about the purpose of carrying out practical science activities. Nokonaota believed that practical work and theory must go hand in hand therefore doing practical work enables the students to re-affirm science concepts they learn in theory. Kakadolo also expressed a similar view and asserted that doing practical science activities helps students understand what he taught them in class. An example that Nokonaota and Kakadolo used to make their point is the topic on cells. They argued that students will have a better understanding of the sizes of cells when they view them under a microscope than just by discussing or giving notes to the students to read and understand.

> Nokonaota: ...important for students to actually see or view the cells so that they have a better understanding of how small cells are...

Lole noted that doing practical science activities helps to reinforce and reemphasize the science concepts they learn in class. In other words, in his view the foremost important reason for teachers planning practical work is to enhance students' understanding about science concepts. He noted that doing practical science activities may also help him evaluate the effectiveness of his teaching and identifying areas where he could improve. Niksen added that one of the purposes of doing practical science activities is because it helps students to visualize and enhance their understanding of the science concepts they learn in class.

Another purpose for practical activities identified by the teachers was to enable students to develop the students' personal skills. Nokonaota believed that doing practical work will help students develop thinking and writing skills, particularly in making constructive conclusions.

Lole and Niksen both highlighted that development of such personal skills help students to think scientifically and learn to report scientific evidence in a logical and constructive manner. They also felt that doing practical science activities provide an opportunity for students to work collaboratively and teaches them also to manage their own learning. All four science teachers believed that doing practical science activities would assist in the development of students' process skills such as observation, measurement , analysis, experimentation and handling of science equipment all forming the basis of the scientific method.

Interestingly, only Nokonaota pointed out that doing practical science activities would help to motivate the students towards an interest in science. He identified activities that involve direct observation in the field and also those that involve changes in colours through chemical reactions as being ones that foster students' engagement.

4.2.3 The science syllabus

The teachers agreed that the science syllabus plays a considerable role in their planning and organizing of practical science activities. They pointed out that the objectives of the syllabus are used as guidelines for planning and designing the practical science activities.

However, they expressed some dissatisfaction about the science syllabus and considered that it needed to be reviewed to cater for new ways of teaching and learning in science. All of the teachers argued that the current science syllabus is content based and provided little chance for practical science activities. Lole's comment sums up their view.

> Lole: The current syllabus is more in terms of content and it requires the students to learn all that content and in my view this is really a draw back for students as well as for teachers.

4.2.4 Science resources

Science teachers from the rural secondary schools said that many activities suggested in the syllabus cannot be done due to a lack of science equipment. They highlighted certain topics which they teach for which they cannot do any practical science activities. For example, Nokonaota said he could not do a practical activity to simulate the eruption of a volcano because the needed chemical reagent was not available. Kakadolo could not do any chemistry practical science activities because he had no chemicals and basic glassware like test tubes. The urban school teachers felt they were reasonably well supplied with science equipment for some practical science activities. Others had to improvise at times.

> Lole: Our science lab here is equipped for chemistry so we have almost all the basic requirements for activities related to chemistry. That is we have chemicals, test tubes and you name it....

4.2.5 Other factors

Other issues that the teachers also highlighted as factors that contribute to what works or not for them include the experience they gain from attending short training blocks, time, and class size. Lole stated that the training he attended on how to use micro-science kits had increased his knowledge about other ways to do practical science activities when there is limited science equipment available.

Time was an issue for all teachers. The teachers noted they could not do some practical science activities because of disruptions caused by factors like the scarcity of food which meant the schools have to close early. This applied to the rural schools. Kakadolo explained that while the official school Calendar started in mid- January 2010 their school did not go back until April as the classrooms needed repairing. Furthermore, they could not complete the term as the food for the students ran out so they closed at the end of May. In the case of day schools, the programs have to be completed by 4.30pm as the teachers have to supervise extra-curricular activities before that time as well.

Class size is also another issue that the teachers reported to affect their planning and organizing of practical science activities. Class size relates to how many students the science classrooms can accommodate. Lole noted that this is a problem for urban schools that attract large numbers due to student transfers from rural areas in search for better education.

4.2.6 Assessment

The science teachers highlighted the importance of assessing students when they are doing practical science activities. All said they assess students' process and personal skills when conducting practical science activities. Lole suggested that assessment could be used for different purposes.

> Lole: Assessments could be about certain skills that they need to develop or content related whether by doing the practical activities has helped the students to understand the concepts better.

Nokonaota and Kakadolo also pointed out the role of assessment in asserting science concepts. Also Niksen highlighted the importance of assessing students if they can follow instructions effectively and are confident in manipulation of science equipment.

Science teachers in urban schools asserted that the assessments are for formative purposes as well as for summative purposes. Formative assessments were mainly for purposes of remedy or identify students' strengths and weaknesses whereas the summative assessments contribute to the students' final grades at the end of every semester (January-June, semester I or July-December, semester II).

However, the science teachers in the rural schools noted that the assessments from practical science activities were summative only. These assessments make up the Internal Assessment (IA) along with other assessment tasks and contribute to their final grade at the end of the semester.

Interestingly, science teachers in the urban schools expressed that the assessment of students also help them to evaluate their own teaching. They pointed out that many teachers only focus on the students' outcomes but do not realize that what students learn is the end products of the teachers' way of instructing or facilitating information. Niksen explained that he gives each student an exercise book each to keep as a journal in which they can record what they liked or disliked about a lesson including doing practical science activities. He collects these books at the end of every two weeks for him to go through and check his students' responses as a way to evaluate his own teaching.

Overall, the four science teachers shared a wide range of views in answering the five interview questions. Some of the views showed some commonalities while others are unique to some teachers. For example, all participants agreed that it is important to assess the students so that the progress of their learning can be monitored. However, the two science teachers in the urban schools believed it is also important to use the assessment of students' practical activities to evaluate their own teaching. The next section presents the photo elicitation of the four teachers about practical science activities.

4.3 Phase 2: Photo elicitation

The photo elicitation, that is the photos the teachers took and their explanations about their photos is presented in four cases. The background of each teacher and the school is presented followed by the descriptions of the teachers' interview with the photos they had taken.

4.3.1 Nokonaota at Greybeach secondary

The first story is about Nokonaota who is a teacher at a rural secondary school. The secondary school is a boarding secondary school with about 200 students which caters from Forms one to five. The school infrastructure includes a two storey building of permanent materials. It has a science classroom which can seat up to 30 students. It has a cupboard, a working microscope and few test tubes with racks but no sinks or water supply. The school has two laptops, one for the principal and the other which the rest of the staff members share, and a photocopier. The school has a portable generator which provides power to charge the laptops and power for the photocopying machines as well as for students evening study up to 9.00pm. Nokonaota is a male science teacher who graduated two years ago at the time of this project and had taught for two years at this school. He had graduated with a Diploma in Science Teaching from the Solomon Islands College of Higher Education in Solomon Islands. These are the photographs Nokonaota took when he was asked to show some examples of activities he would do with his students.

The descriptions about the photographs Nokonaota took are presented below;

Figure 2 Microscope, box of slides and onion

This photograph above shows the resources used in an activity to study plant cells (microscope, a box of slides and onion) by Nokonaota at Greybeach School.

Nokonaota explained that the microscope shown in the photograph is the microscope he normally uses with his students to carry out the practical science activity on cells and activity he had described to the researcher also in the phase one interview (see section 4.2.1). He explained that the school has three microscopes but two could not be used because the lenses had been infected with fungus.

Nokonaota said he would usually prepare the specimens like onion cells on a slide and set it for students to view. The students adjust the fine focus for clarity. He did not allow his students to prepare the onion cells for this activity because he feared that his students might break a part of the microscope which would be very expensive.

For the viewing of the onion cells Nokonaota explained that the students would be organized into groups and each group would then have a chance to take turns. The students were then asked to draw what they saw and their work was collected for assessment. Part of the assessment was to determine their accuracy in drawing what they saw. He noted also that he uses the microscope for studying Brownian motion.

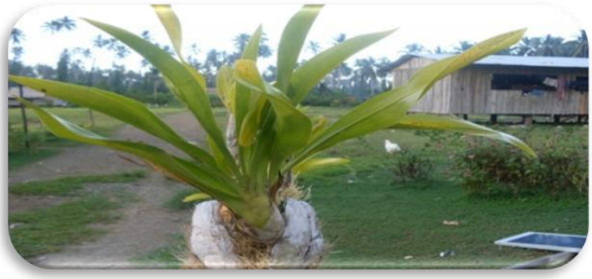

Figure 3

Figure 4

Figure 3 and Figure 4 Two plant varieties

The two photographs show an orchid (Fig 3) and a bean plant (Fig 4) that Nokonaota used in an activity on classification of plants (bean plant and orchid plant).

Nokonaota explained that the above photos represent two orders of plants he studied with his students. The topic was about classifying dicot and monocot plants. Nokonaota explained that in class they studied Angiosperms or flowering plants and the plants shown in the photographs represent the two orders in that class (group). He explained that in this practical science activity, students go outside in the field and identify examples of monocot and dicot plants by looking at the features that differentiate these two orders of plants. After allowing the students to go out in the field he would then have a class discussion about the students' observations in the field. Nokonaota expressed that it was important to do this to ensure that students conducted scientific observations while being outside and did not just enjoy getting outside the classroom. What Nokonaota found out, was that students were very interested in direct observation in the field because they were able to identify different types of plants using the criteria they had studied through the activity. He pointed out the importance of students being able to critically analyse their observations and that he felt a good place to start was at Form 2 level as this would to help them when they pursued science in their later studies. As he noted:

> Nokonaota: I have found some students in the higher classes lack the ability to interpret what they see and may be they did not have enough experience of analysing data effectively during their lower classes.

4.3.2 Kakadolo at Sandfly Secondary School

The second school visited is also a rural secondary school. This secondary school is a boarding secondary school of about 100 students which caters from Forms One to Three. It is about 4 to 5 hours by 15 Horsepower outboard motor engine from Greybeach Secondary School. This secondary school located about 2km from the coast surrounded by virgin rain forest and is close to a stream. The coastline is fringed by reef and black sand beach to the west and white sand beach to the east. The school building has mainly thatched huts although several permanent buildings were completed during the time of the visit including a classroom block. The school does not have any computers or a photocopying machine. The teachers' exam was hand written and scripts had to be taken to the province's centre for typing and photocopying. The school does not have a designated science classroom so all teaching and practical work is done in the same classroom. The school does not have any power supply or even a portable generator so most teaching is done during the day. Students use hurricane lamps or torch lights to study in their dormitories up to 9.00pm. Kakadolo, a male science teacher, graduated two years prior to the undertaking of this research and had taught science in another secondary school before this current posting. Kakadolo also graduated with a Diploma in Science Teaching from the Solomon Islands College of Higher Education in Solomon Islands. His responses are presented below;

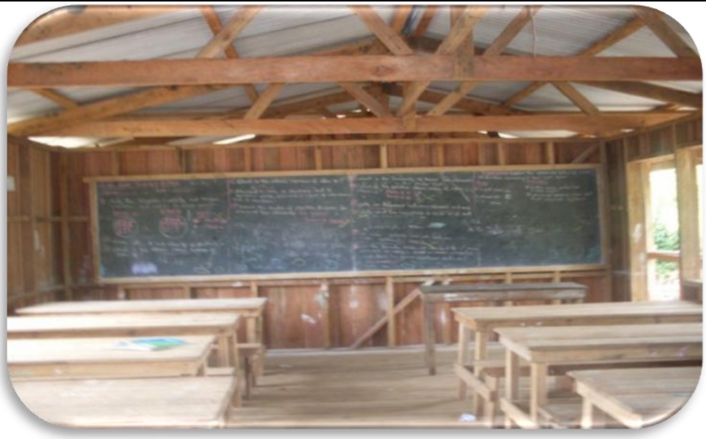

Figure 5 Incomplete classroom block

This photograph in Figure 5, shows the new incomplete classroom block for Form Two at Sandfly School where Kakadolo teaches science and other subjects. The only resources available to Kakadolo were: a blackboard, chalk to write notes, desks and stools for the students to sit on. This photograph tells the story of the method of teaching that Kakadolo would use most of the time.

Kakadolo noted that the reason why he took this photo was to show that the school did not have a purpose built science classroom and no science equipment. He noted that most of the teaching was therefore ‘chalk and talk’ as that is the only basic resource inside the classroom. However, he noted that he conducted class discussions, demonstrations, identification of plant parts and other practical science activities that do not involve manipulation of science equipment. He said that this situation would continue until the school has a proper science classroom.

Kakadolo wished that the school management would meet his request for at least a storage box resourced with some basic equipment and other materials he could collect together for improvising practical science activities. He feels that this is important so that teachers and students can store the resource material they design themselves.

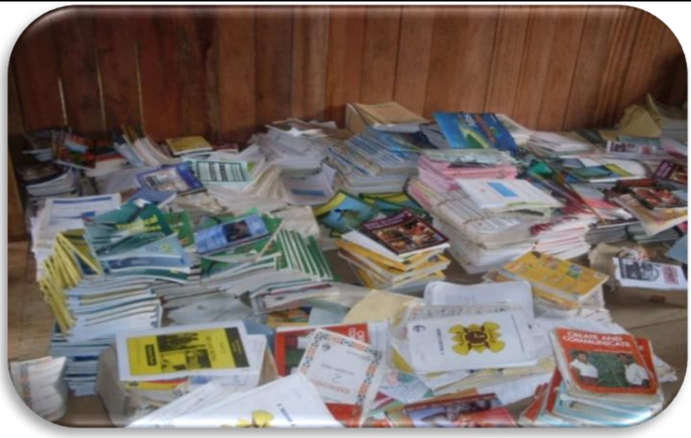

Figure 6 Only set of books

This photograph (Figure 6) shows the only set of books that Sandfly School has for its students. These are scattered all over the floor in a storage room. In this second photograph the teacher further emphasised the challenges encountered at Sandfly School.

Kakadolo explained that a storage room in the new classroom block at the school is currently used as a library. These are the only books that students have as a library resource. The books relate to science and other subjects. He emphasized that their resources for reading were very limited.

In his class he normally gives students some readings from the books to involve them in researching using the books to answer questions. Kakadolo explained that allowing his students to find out answers to questions he gives them assists his students to develop critical thinking skills and the skill to research for answers based on evidence which is the basis of working and thinking scientifically.

He also pointed out that sending them to do library research is also a practical science activity where they get information for their discussion during another class. He highlighted the importance of peer learning where students research for information together and share with each other what they have learnt from the activity.

Figure 7 Parts of guava plant

This photograph (Figure 7) shows a plant that kakadolo used in one of the activities he planned for his students. The photograph only shows the branches and leaves of the plant as the activity only required those parts.

Figure 7 shows the guava plant used in the practical science activity that Kakadolo explained to the researcher during the phase 1 interviews about investigating transpiration of water in plants.

Kakadolo explained that he decided to use this particular plant on this photograph because of its size and close proximity to the classroom for observation during the week long period of the experiment. The students could easily reach the leaves to tie plastic bags around them. He explained that the students would be working in groups and using the same guava plant. Kakadolo said when his students did this experiment the results showed that leaves from different branches of the plant produced different amounts of water and the students were curious about this and queried why. Kakadolo was glad that this activity prompted his students to ask questions which were an indication that learning occurred. He also felt it to be important to evaluate his method of planning and organizing practical science activities for his students.

In this activity Kakadolo also noted that his students had to estimate the amount of water that was produced because they did not have any measuring cylinders. He said they improvised by using jars made from bottles which they put marks on using rulers to indicate the height of water collected. Thinking about this activity on transpiration in plants prompted Kakadolo to consider how he would like to adapt this activity in the future:

Figure 8 Sample of quartz

The photograph (Figure 8) shows a sample of quartz. One of the activities that Kakadolo planned for his students was the identification of rock samples that students collect around and within the vicinity of the school.

Kakadolo explained that the photograph shown was a sample of quartz. He noted that one of the activities was about identification of different types of rocks. He noted this activity involved students going out in the field at locations of their choice to find and identify a rock of their choice. The students used a set of criteria he had given them to identify rocks and minerals. He noticed that students enjoyed going out but were very quiet and seemed to be less observant and analytical when it came to using the guide to distinguish between rocks and minerals.

4.3.3 Lole at Farwest Secondary School

The third school visited study was an urban secondary day school. This school caters for all levels of education from early childhood to secondary education and has a total roll of about 900 students. The secondary component has about 300 students which caters Forms One to Six. The school is located in Honiara, the capital of Solomon Islands and is therefore easily accessible. Students stay with their parents and relatives and attend school every day by bus, own transport or on foot. Although the school does not have enough computers for students many of them access the Internet from the internet cafes in town.

The school has a science lab that is well equipped with science resources. The majority of material resources relate to chemistry and physics and are kept in storage room. The science lab is used by all Forms from Form One to Five when they do science and also during the agriculture classes. Lole the male science teacher graduated two years earlier and had been teaching science in another secondary school before being posted to the current one visited. The science teacher graduated with a Diploma in Science Teaching from the Solomon Islands College of Higher Education in Solomon Islands. Lole selected the following photographs about the practical activities he involves his students in.

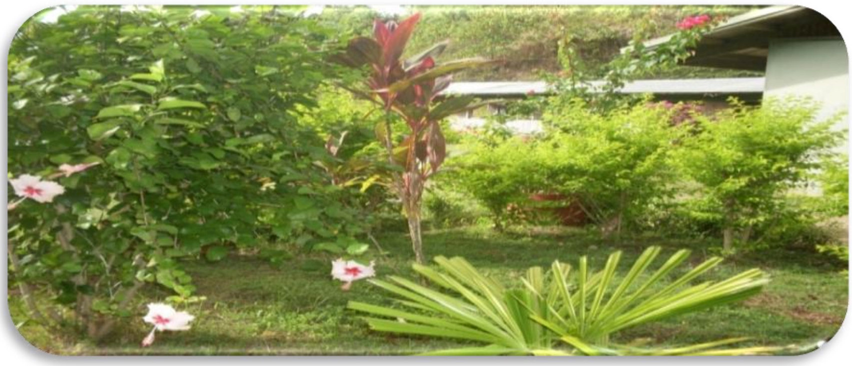

Figure 9 Different plant species

This photograph (Figure 9) shows samples of different plants that grow around the Farwest School that his students normally study to learn about the classification of plants. This activity is similar to what Nokonaota of Greybeach School did as classification of plants is a Form Two topic.

The photograph shows different types of plants and their different parts. Lole pointed out that he took this photograph to show the different plant types that his students used in one of the activities for the classification of plants. The plants are hibiscus plants with flowers and a species of a palm. This activity is based on classification of plants which is one of the topics in Form 2 as also noted by Nokonaota.

Lole explained that this activity was done outside and was done in groups where students were organized in such a way that each member of the group had a task to do. Instructions required students to collect plants and classify them according to differences in reproductive parts, flowers, roots and leaf vein arrangements. He said the purpose of this activity was to allow students to carry out their own observations instead of following step by step instructions formulated by him. Lole said that his task was to facilitate or provide guidance on what they are doing. As such he explained, he would move from group to group to check and assist students. After the outside observations students would continue in the classroom with a classroom discussion led by the students to report their observations. This would then be followed up by individual written reports for assessment purposes.

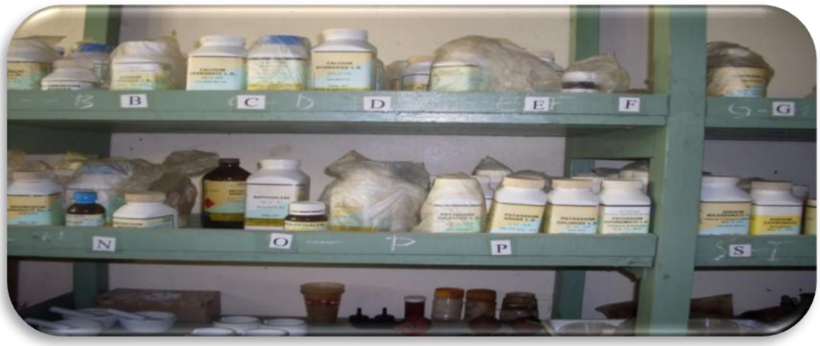

Figure 10 Science resources

This photograph (Figure 10) shows the types of science resources Farwest have to do some of the practical science activities in the lab. What is shown are samples of consumables available and other science equipment they have.

Lole explained that the second photograph shows a part of the storage room in the science lab. The photograph shows some of the consumables (chemicals) and some other resources. Most of the chemicals are salts like Sodium Hydroxide, Sodium Chloride, Calcium Hydroxide and acids like Hydrochloric acid, Sulphuric acid. He explained the salts are used mainly to prepare solutions for carrying out simple chemical reactions like acid base reactions or precipitation reactions. He felt that he liked to engage his students in conducting chemical reactions because they were often fascinated by them especially, those reactions that involved colour changes.

However, he also noted that he improvised at times when some chemical substances were not available like Calcium Hydroxide solution ($Ca(OH)_2$). He explained that he used quick lime or Calcium Oxide which can be easily derived by heating coral, a source of calcium carbonate which is easily obtainable from the sea and partially dissolved in water to produce Calcium Hydroxide.

Figure 11 Science lab

This photograph (Figure11) shows part of the science lab where students normally carry out practical science activities. Lole felt that science classrooms or labs should be set up like this.

The photograph shown according to Lole shows the students work area in the science classroom or science lab to manipulate science equipment or do science experiments. The setting is such that students would stand along the area when doing experiments such as heating solutions or observing chemical reactions occurring in testtubes. The working benches or area allow only two groups to work along the side of the classroom. Lole would arrange the tables for group discussions or group work in the centre of the science lab. After one period of 40 minutes students would typically change over. He explained that in his class where he would have to teach up to 50 students such physical arrangements were vital.

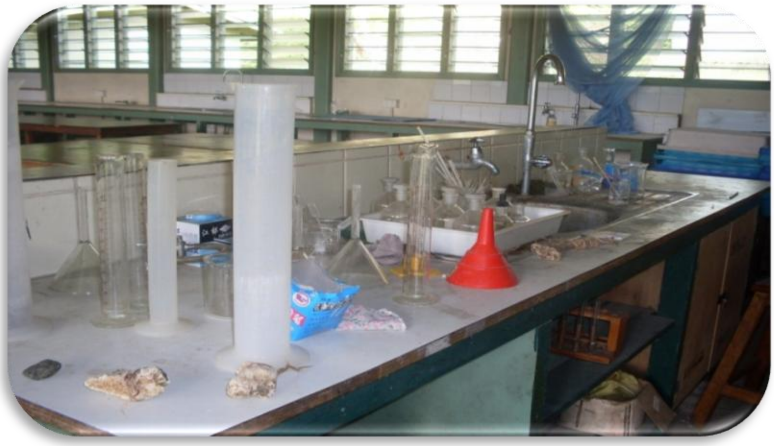

Figure 12 Teacher's preparation table

This photograph (Figure 12) shows the teacher's preparation table. This photograph also shows other science equipment that is available in the lab (measuring cylinders, beakers, test tubes with racks and funnels).

When Lole was talking about his photograph in Figure 12, he explained that he had to prepare solutions or sometimes test experiments a day before to check that the intended activity works before allowing students to do the activity. He stressed that prior preparation and planning was vital and important so that he knew exactly what to look for when students do the activity or if the reagents worked at all. Furthermore, he would do preparations like dilutions of concentrated acid and basic solutions for students because of their hazardous nature. He noted that one of the important things for students to know when doing practical science activities was lab safety and rules. Such safety procedures include students not to play when carrying out a practical experiment in the lab as such behaviour may cause accidents.

He explained that students could also use micro-science kits to carry out experiments (see Figure 13). The micro-science kits have a set for chemistry, biology and physics. For chemistry and biology the kit has a component called a compo-plate composed of a mini-tray and a micro-pipette called a propette to suck solutions up to put in to a compo-plate for observing the reaction.

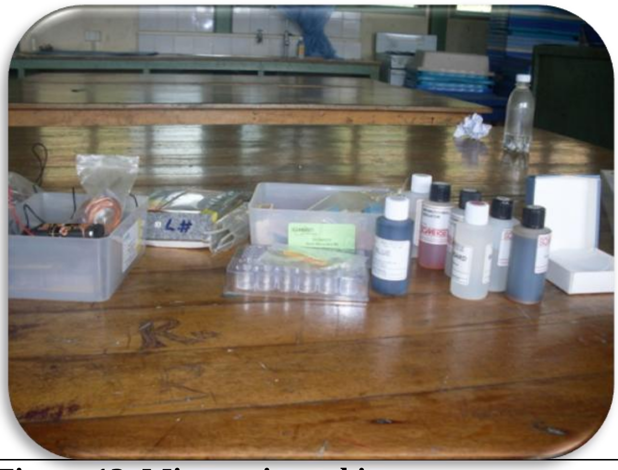

Figure 13 Micro-science kits

This photograph (Figure 13) shows samples of micro-science kits used in Farwest and a sister School in Solomon Islands. The micro-science kits are composed of miniature test tubes, trays, circuit boards etc and are all packed in the white container shown on the left of the photograph.

Some tests that students can do using the micro-science kits are to test for acidity and alkalinity by applying very small samples. Use of very small samples in his view is an important safety measure in the lab. He also recommended that micro-science kits could be an option for schools with very little science resources.
Lole further explained that micro-science kits are easy to handle and each student can have access to one.

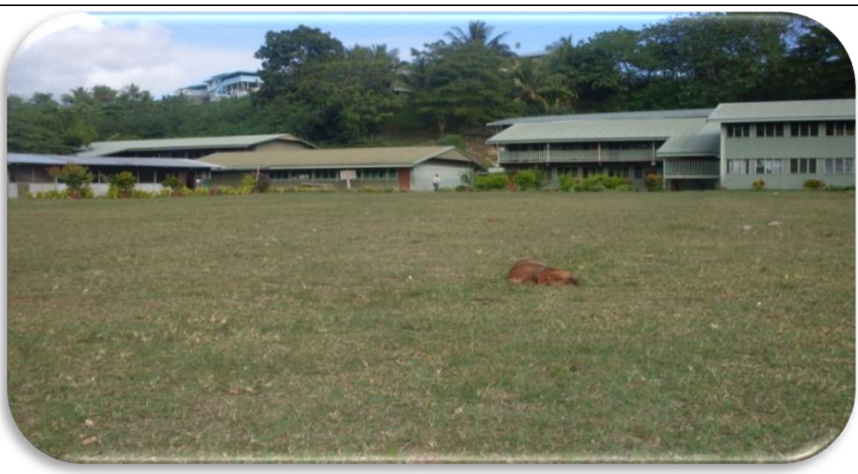

Figure 14 Play ground

This photograph (Figure 14) shows the play ground of the school which Lole normally used for some outdoor activities when science equipment is not enough such as measuring speed and acceleration. They also use the play grounds to do simulating the solar system using the students as subjects.

Lole used to carry out some activities like measuring speed and he explained that in this case students would walk or run while others would measure distance and time. Lole said that students were motivated and very interested when the activity took place outside of the classroom.

Figure 15 Rock boulder

This is a photograph (Figure 15) of a rock boulder Lole used in an activity for looking at evidences of geological forces with his students. This rock boulder is found located within the school area contained fossils of marine shells.

Lole explained that students would use it to study geological products and processes for example by looking for evidence of fossils which would be a clue whether this rock may have formed on the seabed.

He found that the students found imprints of shells and other coralline fossils. This fascinated them and made them think about how the rock arrived in its current location. Lole also remembered that when the students were discussing this, some students who experienced an earthquake in their area in 2007, were prompted to share their stories about how corals reefs which were once under the sea were now above sea level. This concrete learning experience gave the students an opportunity to bring their own stories into the science classroom.

4.3.4 Niksen at Hopeful Secondary School

The fourth school visited was an urban secondary day school called Hopeful. This school caters for all levels of education from early childhood to secondary education like the first urban school for about 1000 plus students. The secondary component of the school consisted of about 400 students catering for Forms One to Seven. The school has its own computer lab connected to the Internet which both students and staff can access. Students live with their parents and relatives and attended school every day by public bus, own transport or on foot. The school has four designated science labs well equipped with science resources for all sciences (biology, chemistry, physics and earth science). As the school offers Form Seven Sciences under the University of the South Pacific (USP) distance flexible learning (DFL), some of the science resources and consumables are provided through this partnership. Of the four science labs one is a general science lab for Forms One to Three and the other three labs are for physics, chemistry and biology lab purposely for Forms 4 to 7.

Niksen is male science teacher who graduated three years earlier from the University of the South Pacific (USP) with a bachelor's degree in science (BSc) majoring in biology and chemistry but with no teaching qualifications. Prior to teaching in this school, Niksen was posted to a secondary sister school, one of the pioneer secondary schools in Solomon Islands which also catered for students up to Form Seven. Niksen's photo elicitation is described below the following figures.

Figures 16 and 17 Mimosa plants

The two photographs in Figure 16 and 17 show the Mimosa plants that Niksen used for various activities to study some of the characteristics of living things (response to stimuli, movement and adaptation).

Niksen pointed out that his students studied Mimosa plants shown on the two photographs under the topic called plant responses and characteristics of living things. He explained that historically this plant is not endemic to Solomon Islands but was introduced by Americans during the Second World War. This plant has many thorns and is very sensitive to touch resulting in the leaves and stems folding immediately when they are touched. During the Second World War the Americans planted this vine which was used to show the tracks of Japanese as enemies when the leaves and stems folded after they walked through the plants. For this activity students were given hand outs on what to do to the plant and how to make observations. They would work in groups to investigate how the plant responded to different levels of touch (light, medium and heavy). The students were to investigate how long the plant would take to restore its leaves at the different levels of touch by recording the time. Niksen explained why he had selected this plant as an example.

> It is a very good learning material that students can use to study one of the characteristics of living things…the ability to respond to any stimulus.

Niksen also explained that the students also studied the concept of adaptation using the same plant. Being carnivorous they could study how the plant would trap its prey. He felt that this fascinated students because he knew that the students had learnt during their primary years in science that only animals were carnivorous.

The plant was also used to study another characteristic of living things, like movement. Niksen noted that many people think that plants do not move but allowing students to see that the giant memosa folds its leaves and stems when touched is evidence that plants do move and that movement is a characteristic of living things.

Niksen described further that during these activities he would give his students a hand out to answer questions he prepared to check if the students actually did some observations related to some of the characteristics of living things (respond to stimuli, movement and adaptation).

4.4 Emerging themes from the teachers' photo elicitations

The photo elicitation allowed the four science teachers to provide situated and contextualised examples of their teaching practices. There were some commonalities in the practical activities they showed as well as some differences. The commonalities were mainly related to the activities the syllabus suggested while the differences were related to whether the schools had the resources to conduct the practical science activities. Teachers explained that practical activities could be done inside and outside of the classroom, involve specialised resources as well as materials that were freely availble. Teachers told stories of practical activities that invite students to think and reflect and get actively involved in science investigations, as well as share very personal stories. At closer inspection ten themes emerged that will be described next.

4.4.1 Science activities are diverse and can take place in and outside the classroom

This theme emerged from the four science teachers' perceptions and understandings about what a practical science activity is and the types of practical science activities they identified. The four science teachers expressed similar views about the types of practical science activities they would plan and organize for their students. The four teachers felt that practical science activities can be any form of activity organized in a science classroom or outside the classroom but that the aim would have to be to enhance students' understanding about science. Examples of types of practical science activities that the four science teachers noted were diverse and included classroom exercises, worksheet work, library research, practical experiments and investigative fieldwork. What this implies is that the science teachers realized that doing practical science activities is more than doing experiments.

4.4.2 Contextualising science

The four science teachers noted that it is important to contextualise science through conducting of practical science activities to enhance students' learning. While all four science teachers raised the importance of contextualizing science, the two science teachers in the rural secondary schools said that they apply this idea to many of the practical science activities they organise for their students. However, the reasons for these were mainly due to the non-availability of science equipment as highlighted on the theme on access to resources. This may imply that they are not fully convinced or aware of the value such contextualised experience might have for the students. The two science teachers in the rural secondary schools had to put extra effort by using whatever resources were available to them within the school and its surroundings. Nokonaota and Kakadolo allowed their students to go out of the classroom and actually study plants in the environment other than bring plant specimens to the classroom. The science teachers in the rural secondary schools had to think beyond what had been suggested in the science syllabus when planning and designing practical science activities for their students. This was illustrated well on the choice of practical science activities the science teachers decided to take photographs of to tell their story.

The two science teachers in the urban secondary schools also told stories about practical science activities they had prepared for their students that contextualized science. Lole for instance took his students outside the classroom to study plants, as well as examine a rock boulder to study the effects of geological forces. In both cases the teachers took their students to real life settings to study science concepts and enabling the study of science to be more relevant.

4.4.3 Science activities to re-affirm, reinforce and re-emphasise scientific concepts

This theme identifies the four science teachers' perceptions about the purpose of students being involved in practical science activities. They voiced similar sentiments that practical activities are important and essential for students' learning in science. The teachers felt that the activities students were involved in would assist them to better understand the nature of science as well as science concepts they were learning in class. The teachers said practical activities were valuable because they were not teacher directed instructions. They saw that the practical component was essential to re-affirm, reinforce and re-emphasize science concepts. Nokonaota and Kakadolo highlighted that their students did not fully understand how small cells were until they conducted the practical science activity using the microscope to view onion and chick cells.

4.4.4 Visualising science concepts

The four science teachers stressed that doing practical science activities assists students to visualize or construct a correct picture in their mind about the science concept being taught. Teachers were conscious of students' different learning styles and the constraints they encounter when dealing with highly abstract ideas. They highlighted while some students understand and learn by listening to their teachers, other students need to see, feel and engage practically. Practical science activities are also vital in addressing concepts that are abstract and more difficult to understand.

4.4.5 Science activities to develop process skills

Developing students' process skills was viewed by the four science teachers as another purpose of carrying out practical science activities. The skills the teachers identified include observational skills, recording skills, and skills in the manipulation of science equipment. The four science teachers expressed that these skills are important for students to develop through carrying out practical science activities as they are the basis for scientific work. The teachers commented that when students master these skills it helps them to understand the essence of what is meant by making scientific observations and they highlighted this to be an important component of the nature of science. They emphasised that such skills needed to be practised so they could be transferred from one situation to the next so students would develop a better understanding on how to think systematically. Doing practical science activities would help students develop students' ability to collect and collate good results. In addition they believe that learning of such skills have to begin at a lower class such as Form Two so that students can continue their to build up that capability as they progress to higher classes.

4.4.6 Science activities to develop thinking skills and build confidence

Another theme that transpired was that the four science teachers considered that involving students in practical activities assisted them in the development of thinking skills. They highlighted that students need to think carefully and critically to be able to construct meanings about what they do. They felt that such experiences were important to learning science but that they were also transferable skills and highly valuable for students' learning. Teachers also commented also that practical science activities develop students' confidence in themselves to do science. Students develop the ability to plan and organize their own learning and such experiences can be very motivating. The teachers also felt that doing practical work would provide good opportunities for students to reflect on their own learning and build their confidence about their achievement in science.

4.4.7 Science activities increase motivation

One of the science teachers noted that another purpose for carrying out practical science activities is to motivate students to be interested in science. He expressed that his students show interest and enthusiasm when they become involved in practical science activities especially those that involve manipulation of science equipment or experiments such as chemical reactions that result in observable changes (ie. colours). Most students also appeared to enjoy practical science activities that involved making direct observations in the field. The other science teachers pointed out the importance to provide guidence to students when doing outdoor activities so that they do not only enjoy going out but also observe scientifically. The teachers explained that the students would either write a report for the teacher to mark or would report verbally in the form of a class discussion led by the students.

4.4.8 Science activities and the role of assessment

All four science teachers said that assessment of practical science activities plays an important role in enhancing students' learning. They pointed out that assessment of practical activities can be formative or summative. Teachers said that they would be able to assess students' understanding of content knowledge as well as how well they master the different process skills that form the basis of the scientific method (observational, analytical, practical and experimental). The science teachers noted that they would assess their students from the reports they write and submit, or assess the skills they demonstrate while carrying out the investigation. They also highlighted that assessments are done using certain criteria which include how accurately the students have conducted their observations or whether the conclusions derived actually answer the aim of the activity and also, whether students follow instructions correctly when handling science equipment. This is similar to what Nokonaota and Niksen expressed.

> Nokonaota: ....if they can relate to what is in theory in terms of how students carry out observations or thinking skills and also analysis of data...

Niksen: ...whether they use the instruments correctly or not...

The teachers also stressed the importance of using practical science activities for formative assessment to assist the students to address in areas they need to improve which could include science concepts, procedures of some practical work and practical skills. They noted that teachers sometimes overlook the importance and opportunity formative assessment provides for students' learning and only concentrate on summative assessment for reporting the students' grade at the end of every semester. However, Lole and Niksen pointed out that assessing students work also helps teachers to evaluate their own teaching or how they plan and organize practical science activities for their students. The students' marks are used to gauge how well they have been teaching. If students get low marks it is an indication that students were not clear about what they were learning. Therefore they suggested the importance for teachers to not only concentrate on students work but consider also their teaching or the way they facilitate their teaching and learning process.

4.4.9 Science activities and the influence of the science syllabus

The science teachers agreed that the science syllabus played an important role in planning and organizing practical science activities for their students. They noted that the syllabus suggests certain practical science activities for every topic. The suggested practical science activities fulfil certain objectives in the syllabus including understanding of science content. However, the science teachers pointed out that the syllabus does not adequately address other learning outcomes like improving students' process skills. They also noted that at times what is suggested in the syllabus cannot be done in class due to a wide range of constraints including non-availability of science equipment and time factor. Furthermore, they expressed that the current science syllabus is full of content and sometimes results in teachers spending more time in trying to cover theory and run out of time to do practical science activities. Therefore, they recommended that a review of the syllabus should be undertaken so that both theory and practical work can be given ample time to cover. They also suggested that the practical science activities should aim to address a wide range of specific objectives other than to address understanding of content only. However, these difficulties encountered by the teachers have enabled them to think outside the syllabus at times and work with what is available to them. This has been highlighted especially by the two teachers who teach in the rural secondary schools.

4.4.10 Science activities and the access to resources

The major constraints that the four science teachers identified that affect them at times when planning and organizing practical science activities were access to resources. This constraint was experienced differently by teachers from the urban and those from rural secondary schools. The two science teachers in the urban secondary schools considered access to resources as a constraint in terms of the quantity of science equipment their school had for number of students per class they have. They highlighted that there has been an influx in student enrolments resulting in large class sizes and not enough science equipment although they said that they had most of the basic science equipment and consumables. Limited access to science resources however was a serious constraint for the rural secondary school teachers. The two science teachers expressed the wish that their school administration would work towards providing their school with a science classroom with plenty of science equipment. Kakadolo highlighted this by showing photographs of the difficulties he encountered like the photograph of the only classroom his students used for all subjects. (see Figure 4). However, encountering such limitations in science equipment has prompted the science teachers to become resourceful and innovative and look for alternatives by improvising with locally available materials.

4.5 Summary

This chapter presented the results and began with a brief description of the data collection process. The study involved twos teachers from two rural schools and two teachers from two urban schools in Solomon Islands. The data collection process involved two phases starting with an interview. Transcripts were returned to each teacher for verification. The second phase involved teachers taking photos to illustrate their practices around practical activities which were used to elicit teachers’ views further in a second round of interviews.

Section 4.2 provided the descriptions of the answers the teachers provided to the five semi-structured questions the researcher asked the teachers during the interview. The four science teachers expressed a wide range of views around the purpose of practical science activities and the influence of the science syllabus. Teachers' answers were also presented around their ideas of the constraints and opportunities they encounter in planning and organizing practical science activities and assessment.

Section 4.3 presented the photographs taken by each science teacher and their descriptions. Each science teacher told their own story. Differences between the stories told by the teachers related to opportunities and constraints they encounter in terms of access to resources. The teachers in the rural schools expressed concerns about limited access to science resources compared to their urban counterparts. However, they appeared more resourceful by improvising and contextualizing science activities using locally available resources and are relevant.

Finally, section 4.4 provided the descriptions of the themes identified from analyzing section 4.3. There were ten themes identified and commonalities were related to the science syllabus and differences were related on access to resources.

The next chapter will present the discussion of this study in the light of the research questions and in consideration of the literature.

Chapter Five: Discussion

5 Introduction

This chapter presents the discussions of the findings described in chapter 4 in relation to the three questions that this research set out to answer. As introduced in chapter 3, the three questions were:

1. What are F2 urban and rural secondary science teachers' perceptions about the purpose of practical science activities?
2. What do teachers report about their experiences in carrying out practical science activities?
3. Are there differences between urban and rural schools?

To answer the questions above this research study adopted the interpretive paradigm involving photo elicited interviews with teachers to provide an opportunity to hear their views and perceptions and be able to interpret them. The discussion chapter provides interpretations of the teachers' recorded views and making sense of this information in the light of the literature. The discussion reviews the findings from Chapter 4 to identify the emerging three themes relating to (a) teachers' perceptions about the purpose of practical science activities, (b) the enablers and constraints to conducting activities in science as well as (c) the differences between rural and urban schools in light of literature. Those three themes will be discussed in the next sections, followed by the limitations, implications and final thoughts.

5.1 Perceptions about the purpose of practical science activities

After a closer inspection of the ideas about the purpose in doing practical science three themes were identified:

- Re-affirm theory, visualizing science and contextualizing science to support learning about the nature of science
- Development of thinking and process skills
- Motivation and building confidence

5.1.1 Re-affirm theory, visualizing science and contextualizing science to support learning about the nature of science

The teachers in this study identified that one of the purposes for doing practical science activities is to confirm, re-affirm, reemphasize and verify scientific facts (Clark, 2008; Foulds & Rowe, 1996; Gatt, 2004). Doing practical science activities allows teachers to see whether students have been able to make sense of what had been taught in theory to see if students can "demonstrate understanding of a scientific idea, or concept, or explanation, or model, or theory." (Millar, 2009, p. 8). Doing practical science activities allows students also to visualize science concepts that are abstract which was an important reason for the teachers to consider practical activities and is consistent with the views aired in literature (Wallace & Kang, 2004). Subsequently teachers saw that science at school needs to start by the teacher providing content information then engage in practical science activities to verify scientific ideas that had been studied. However, teachers only considered a standardized procedure in setting and conducting such activities. Teachers did not report to be actively looking for new ways of conducting practical activities and there has been some cautioning if doing practical science activities is only used as a way to consolidate theory learnt in class (Rubin e tal, 2003, Fung, 2002 as cited in Mbajiorgu & Reid, 2006) because the whole purpose of carrying out practical science activities is to generate scientific information to understand natural phenomena.

Practical science activities underpin aspects around the nature of science but if teachers are not clear about the purpose for doing practical work these overarching purposes may be lost (Jenkins, 2003; Millar, 2009). In this study the teachers saw that practical activities form a distinctive part of science education at schools however their rationales for doing so was not always that explicit and may indicate that science teachers may need appropriate training focusing on the nature of science and how to conduct more practical activities in class (Yaman & Nuhoglu, 2010).

In their activities that the teachers in this study reported, they also highlighted that practical science activities are particularly meaningful for their students when they were contextualized. Such an approach portrays the ways how scientists engage in scientific inquiries as that is how an understanding of natural phenomena is attained (Abd-El-Khalick et al., 2008). Studies support this view and noted that one of the ways to contextualize science is through investigation of real life experiences or situations to generate understanding (Rivet & Krajcik, 2004).

5.1.2 Development of thinking and process skills

The teachers in this study noted that doing practical science activities would enable their students to develop various skills including observational skills, analytical skills, recording skills, thinking skills, handling skills, organizing and working collaboratively which could be categorized under cognitive, practical and affective domains. Rambuda and Fraser (2004) aired similar ideas which include to classify, predict, measure and to infer from those skills how to conduct a scientific inquiry. In this study two teachers noted the reasons why their students should learn how to do scientific observation and other skills was because they are necessary to generate scientific knowledge. This view is consistent with those proposed in the literature (Johnson et al., 1997; Richardson et al., 2008).

Generally it can be said that the teachers in this study valued the importance of their students acquiring various skills because it would help them understand occurrences in nature. This view is consistent to what Swain, Monk and Johnson (1999) who pointed out the importance for students to master the scientific method. However, it has been cautioned that some teachers do not explain to their students why they should learn the different skills (Ango, 2002) and when the rationale is missing and most of the planning for practical science activities are done by the teachers students may not learn the skills (Coughlin & Hannafin, 2003). This was at times evident in the explanations the teachers provided here.

5.1.3 Motivation and building confidence

One of the four teachers in this study highlighted that a purpose of doing practical science activities is to motivate students. This view is supported by various researchers (Manaf & Subramaniam, 2004; Staver, 2007; Sterling & Frazier, 2008). This teacher noted how his students were motivated when they were engaged in practical science activities that were interesting including outdoor investigations. Brodie (2006) noted that students loose interest in science after entering secondary education therefore doing practical science activities that are interesting could encourage more students to like and enjoy science. Furthermore, students can become interested and motivated in doing science when practical science activities are contextualized in their daily living experiences (Zain, Rohandi, & Jusoh, 2010).

It has been suggested for science teachers to move away from facilitating experimental work using pre-formulated texts to engage in more on hands on activities that are interesting and fun for students (Roscorla, 2009; Yagenska, 2007). However, while students may be fascinated about doing practical science activities it does not mean that this enables students to learn science (Byers, 2002). Practical work can be interesting and engaging but it might not motivate students as motivation is intrinsic and is influenced by other factors (Abrahams, 2009).

The teachers also pointed out that a purpose of doing practical science activities is to help students to build their confidence in doing experiment work in science. This view is consistent with a study in UK on the purpose of doing practical work (Woodley, 2009). The teachers in this study also highlighted the importance for students to work collaboratively to build up the confidence of students who are reserved. This view is in line with sentiments aired in literature (Haigh, 2007).

5.2 Enablers and constraints to carrying out practical science activities

Teachers referred to a number of factors that affect how they conduct practical activities in the science classrooms. The following themes were identified and will be discussed in the following sections:

- Science syllabus and assessment
- Impact of access to science resources, training, time and class size

5.2.1 Science syllabus and assessment

The science teachers in this study expressed that while they appreciate that the syllabus provides them with guidance about how they plan and organize practical science activities for their students they also highlighted some weaknesses. Concerns were related to the amount of content that had to be covered limiting time to complete some practical science activities. Countries that adopt syllabi with heavy emphasis on content knowledge report that this impacts negatively on time to complete practical science activities (Bev & Romanyshyn, 2010; Kenneth.J.Schoon & Sandoval, 1997). The teachers in this study felt that the science syllabus therefore required reviewing. Typically the types of practical activities that the science syllabus suggest are those that require the use of science equipment like microscopes, glassware including beakers and test tubes which rural schools do not have.

The purpose and emphasis of assessment of practical science activities in the science syllabus also influences teachers' decisions to plan and organize practical science activities. The teachers in this study concentrated on selecting practical science activities that they felt would contribute to the students' knowledge supporting the final examinations at the end of every semester. High stake assessments such as the ones in Solomon Islands typically concentrate on tests and exams results and typically result in teachers teaching to the test dominating over other tasks that are often not being examined in those tests like practical science activities (Berry, 2008).

Two teachers in this study talked about the importance to use both formative and summative assessment to assess their students as well as use marks of their students to gauge their own teaching which has been described to be beneficial for teaching and learning science (Cheung & Yip, 2003).

5.2.2 Impact of access to science resources, training, time and class size

The findings have shown the one of factors that influences the teachers' decisions to plan and organize practical science activities is their access to resources. This view is strongly supported in the literature (Mji & Makgato, 2006). The teachers in this study were conscious about the difficulties they encounter as result of lack of access to science resources and the need to improvise while not distorting the purpose of the activity. Musar, (1993) pointed out that when science equipment or resources are not available it is difficult at times to do the practical tasks especially if they have been suggested in the science syllabus. Such difficulties were particularly encountered by the teachers in rural schools, and subsequently required them to be creative and use local resources. Ajibola (2008) aired similar sentiments about how science teachers in some African nations have to improvise using low cost materials to do practical science activities due to lack of adequate science resources.

Teachers' training, available time and class size also influenced the planning and organizing of practical science activities. Reminded by in-service training one of the teachers in the urban schools used and recommended the use micro-science kits as a remedy to schools that have difficulties with access to science resources. In-service training provides opportunities for teachers to review existing practices and learn about new teaching strategies in science (Nivalainen et al., 2010). Time can also influence planning and organizing of practical science activities particularly if the school culture is one where punctuality is not a core aspect of teaching (Roth et al., 2008). The teachers in this study have encountered constraints related to time as a result of disruptions to school programs due to unforeseen circumstances beyond their control. Class size has been a constraint for the urban schools due to greater numbers of students but this was less of a problem for rural schools. This view is consistent to what has been reported in literature where class size has always been an issue especially in urban secondary schools (Centra, 2009; Conoley & Hildick, 2007).

5.3 Differences between urban and rural schools

The Looking at the differences that exist between the teachers' practices who were from urban and rural secondary schools the following themes could be identified.

- Rural and urban secondary school in Solomon Islands are differently equipped and supported

- Teachers' perception that "lab is best"
- Resourcefulness of teachers when resources are scarce

5.3.1 Rural and urban secondary school in Solomon Islands are differently equipped and supported

The urban and rural secondary schools in this study were differently equipped. From what the teachers explained and documented in the photographs urban schools were better resourced compared to those in rural schools and similar findings have been noted elsewhere (Baird, Prather, Finson, & Oliver, 1994). Amongst the resources urban schools had access to modern communication facilities including access to the Internet which was not the case for the rural schools. Access to online resources has been reported to be often better for urban schools compared to their urban counterparts (Eminah, 2004; Lawless, 2009b). Urban science teachers reported also more exposure and greater chance to be involved in workshops and conferences to be updated with new methods of teaching and learning science including practical science activities. There is a concern that rural science teachers sometimes lack exposure and opportunity to attend in-service training if such programs occur predominantly in the urban centres (Zakaria, Daud, & Meerah, 2009).

5.3.2 Teachers' perception that "lab is best"

The science teachers in this study reported that they had conducted a variety of practical science activities however they felt overall that for practical science 'lab is best'. Such views are influenced by the teachers own experiences back when they were at school where much of the practical work was done in labs using pre-formulated manuals and instructions. It is not uncommon that science teachers teach or do things exactly as how they were taught during their own secondary and tertiary education (Iqbal, Azam, & Rana, 2009). Teachers also like lab activities as this is how they see scientists do their work. Studies conducted in some Asian and Middle East countries with pre-services teacher candidates portrayed similar views that scientists conduct their investigations in laboratories (Fung 2002, as cited in Demirbas, 2009; Rubin, Bar, & Cohen, 2003).

5.3.3 Resourcefulness of teachers when resources are scarce

Interestingly, while rural schools were less well resourced, teachers were more resourceful using locally available materials and environments compared to their urban counterparts. Teachers from rural secondary schools have to be creative at times to use what is available to them to carry out practical science activities (Dillon et al., 2006; Lake, 2008; Wahyudi & Treagust, 2004). The findings in this study also showed that rural schools were often close to natural settings including forests, streams and coral reefs that teachers could incorporate in their teaching compared to their urban counterparts. Such observation is in line to what Thomas and Sheerman (2006) called "Out of Classroom Learning" where the environment becomes the learning arena which does not require the standard science equipment.

However, the rural teachers reported that there are practical science activities where they cannot improvise. Non-availability of resources like microscopes or some specific equipment and glassware become an obstacle for teachers to work around making it impossible for teachers to carry out some practical science activities (Bradley, 2000).

The findings from this study present possible impacts for future research and ideas to take forward by policy makers and practitioners. These suggestions are discussed next.

5.4 Implication to research

This research was conducted in light of the growing debate on whether doing practical science activities in secondary schools enhance students' understanding about science (Hodson, 2005; Hoftsein & Lunetta, 2004; Millar, 2004). The findings of this study seem to support some of the concerns and show that teachers highlighted different purposes for conducting practical science activities. Future research may wish to explore further why the different purposes highlighted are important for students know. This research was a small study involving only four science teachers. More research may wish to look at a larger sample.

Research could also observe the teachers as they conduct practical science activities with their students. Furthermore, students may also be included as participants in research to identify their views and ideas. Study about this topic could consider other pacific island nations especially in the western pacific region including Papua New Guinea and Vanuatu or the Melanesian countries as science was introduced to these in a similar way as Solomon Islands (Taylor et al., 2004). Too little research is concerned with the purpose of doing practical science activities where an understanding is needed to support science teachers doing practical science activities as an important aspect of the nature of science (Abd-El-Khalick et al., 1998).

5.5 Implication for policy makers and practitioners

The findings of this research also draw attention to different areas that practicing teachers and policy-makers especially curriculum developers in Solomon Islands may want to take into consideration. One of these areas is the science syllabus which the teachers in this study viewed as being very content based and with less emphasis on doing practical science activities. The current review of the primary and secondary science curriculum which aims to emphasize more on hands on activities which are more students centered may want to consider some findings from this research. The objectives of the science syllabus would be more specific to specify the types of scientific skills the suggested practical science activities can support.

The research study also implied that there is a need for science teachers to be versed with the importance of practical science activities as an aspect of the nature if science. This could be supported through pre-service and in-service training.
In considering the outcomes from this research it is important to identify the limitations of this study. These will be presented in the following section.

5.6 Limitations of the study

This study had its limitations. It was qualitative in nature and involved a very small sample of two science teachers in rural secondary schools and two in urban secondary schools. This small sample does not necessarily represent all science teachers teaching Form 2 classes in rural and urban secondary schools in Solomon Islands. Another limitation of this study may is related to the nature of semi-structured interviews which are open ended and would result in getting open ended answers which may place more emphasis on some aspects that come up during the interview while others might be neglected although probing was done to get more information about an issue.

5.7 Final thoughts

This research study sought teachers' understanding of the purpose of carrying out practical science activities. The teachers in this research study saw the purpose of doing practical science activities in developing students' cognitive, practical and affective skills. The study provided an opportunity for them to articulate a rationale for students to attain the different skills.

The science syllabus and access to science resources are important factors that influence teachers' planning and organizing of practical science activities. This draws attention to the science syllabus which needed to carefully review the content and objectives for conducting practical science activities teachers may use. Resources can involve access to science labs and science equipment but may very well include practical science activities which draw attention on context and resources that are locally available and relevant.

This study detected differences between rural and urban schools in particular in the ways rural science teachers incorporate the environment where as urban teachers made more use of science labs and science equipment and technology like internet facilities to access information to assist them in their planning of practical science activities.

Overall this study found that the rural and urban teachers have valued practical science activities as an important part of science teaching and learning. However, more work such as this would benefit research and probably other teachers to think about the link between the nature of science and practical science activities.

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Appendix A: Letter to Permanent Secretary Ministry of Education

[Name and Adress of Researcher]

[Name and   Address of Permanent Secretary]

Dear Madam,

Subject: Notification of research

My name is Ellison Giano and I am from Isabel province. I am currently a Master of Science Education student at the University of Waikato New Zealand. Prior to undertaking my master's research I have been a science teacher for the last fifteen years both in secondary schools, Solomon Islands College of Higher Education and the University of South Pacific, Solomon Islands Campus.

I hereby officially submit this letter as a notification to your office in regards to a research study I would like to conduct in Honiara and Santa Isabel for my Master of Science Education Thesis. This research will be conducted between May and June 2010. For this research a school under the [Education Authority] in Honiara and two schools under the [Education Authority] will be engaged respectively. These schools are [schools]. For this research I intend to work with 4 Form two science teachers from the above schools specifically 2 science teachers from Honiara and 2 science teachers from Isabel. These teachers will be invited through an initial approach through their Principal to participate in individual semi-structured interviews as well as photographing examples of their practical science activities. These photos will not include any student or other personnel.

The interview time and photo-elicitation will be conducted during a time convenient to the participants ideally during official school hours. I will be prudent, not to interfere or disrupt in any way the school's official timetable. Each interview will not exceed 50 minutes. Each interview will be audio recorded and later used for analysis but specific permission will be sought from each participant.

This research will adhere to the University of Waikato Human Research Ethics Regulations (2008). In this research, the participants' inputs will be respected and

termed as confidential. They will be informed on the outset about the ethical issues surrounding the research and their personal wellbeing. Such ethical issues include their right to decline and withdraw from participating or if they did not wish to continue any further in the process. Pseudonyms will be used instead for both the names of the schools and the participants. Informed consent will be sought from the schools and the potential participants. Schools will receive a summary of the findings after the study has been completed.
I hope this is sufficient for your purpose and I thank you so much for acknowledging this notification letter.

Yours Sincerely
Ellison Giano(Mr)

Appendix B: Letter to Principals

[Name and Address of Researcher]

[Name and Address of Principals]

Dear Sir/Madam,

Subject: Seeking approval for research in [School]

I am currently a Master of Science Education student at the University of Waikato New Zealand. Prior to undertaking my master's research I have been a science teacher for the last fifteen years both in secondary schools, Solomon Islands College of Higher Education and the University of South Pacific, Solomon Islands Campus.

Currently, I am processing matters relating to my research which I intend to implement between May and June 2010. In my research I am interested in practical science activities. I wish to explore the experiences and practices of Solomon Islands science teachers from both urban and rural secondary schools. I would like to gather information regarding how they do practical science activities and the challenges and opportunities they identify when they carry out practical science activities with their students.

I would like to work with a science teacher from your school for this study, in particular Form 2 science teacher. I would like to engage with the science teacher in a series of short activities that include two interviews not exceeding 50 minutes each. I would also like to ask the teacher to take a few photos of some of the practical activities they enjoy doing with their class. The second of the previously mentioned interviews will provide an opportunity for the teacher to use those photos to tell or explain why they have chosen those activities. The interviews will be audio-recorded if the teacher doesn't object and the teacher will also receive a full transcript of the interviews conducted to look through and edit if he or she see fit. Photos will only be used if the teacher is happy to give permission to do so. No photos will be used that include images of students or other personnel or any identifying features of the school in order to guarantee full confidentiality. See as attached is the interview schedule.

Day 1. Briefing with school Principal and teacher participant.

Day 2. Carry out semi-structured interviews with participants including audio recording of interviews (40 to 50 minutes).

Day 3. Teacher participants receiving transcripts and given the opportunity to edit transcript.

Day 4. Teachers taking photos, uploading images in teacher/researcher discussion.

Day 5. Teacher participants receiving transcript of photo story for review and opportunity to edit.

The interviews will be conducted at a time that is considered and agreed upon your administration in consultation with your Form 2 science teacher. I wish to assure you that the research will strictly adhere to the University of Waikato's Ethical Conduct in Human Research Activities Regulations (2008).

If you agree for your teacher to participate, your school and the teacher retains the right to decline and withdraw from participating if they do not wish to continue further in the research process. An informed consent seeking approval will to be signed prior to this research being conducted. Your Form 2 science teacher will also sign a consent form.

Therefore, prior to undertaking this project I wish to seek your permission as the Principal of this school. It is very much appreciated if a copy of this correspondence is given to the teacher responsible for teaching science in Form 2. This is so that times can be arranged for the actual implementation of the interviews.

If you agree on using your school and science teacher in this research, please fill in the consent form below.

I await your response. If you require further information I can be contacted through email on [email address of researcher].

Thank you for your consideration.

Yours Sincerely

Ellison Giano (Mr)

Appendix C: School Principals' Consent Form

I have read the attached letter of information.

I understand that:

1. My school's participation in this project is voluntary
2. You are asking my Form 2 science teacher to take part in series activities that include interviewing of my teacher of not more 50 minutes, taking photos of samples of practical science activities and audio-recording of the interviews.
3. I have the right to withdraw my Form 2 science teacher any time, and my science teacher has the right to withdraw at any time. This will mean that any data collected from my teacher will be destroyed and no further data will be collected from the teacher.
4. All data collected from my science teacher will be kept confidential and securely stored.
5. I understand that my science teacher will not be identified in the transcripts excerpts of discussions, photos nor from the interviews.
6. All data will be reported anonymously using pseudonyms so confidentiality of my science teacher is maintained.
7. I can direct any queries to my [supervisor] at [email address]
8. For any unresolved issues, I can contact the project [co-director]

Please cut along this line and return

____

I give consent for my Form 2 science teacher to be involved in this project under the conditions set above.

Name of Principal: ________________________________

Signed by Principal: ________________________________

Date:____

Appendix D: Participants’ Consent Form

I have read a copy of the attached letter to my school Principal inviting me to participate in Mr. Ellison Giano’s research project.

I understand that:

1. My participation in this project is voluntary.
2. You are inviting me to take part in series activities that include interviewing of my teacher of not more 50 minutes, taking photos of samples of practical science activities and audio-recording of the interviews.
3. I have the right to withdraw from participating in this project at any time. This will mean that any data collected from me will be destroyed and no further data will be collected from me.
4. All data collected from me will be kept confidential and securely stored.
5. I understand I will not be identified in the transcripts excerpts of discussions, photos nor from the interviews.
6. All data will be reported anonymously using pseudonyms so my confidentiality is maintained.
7. I can direct any queries to [Supervisor].
8. For any unresolved issues, I can contact the project co-director [Supervisor].

Please cut along this line and return

I give my consent to be involved in this project under the conditions set above.

Name of Science Teacher: ___________________________________

Signed by Science Teacher: __________________________________

Date: ____

Appendix E: Interview questions for Participants to answer.

1. Tell me about your favourite practical science activities you like doing with your students?
2. Tell me about what purpose do you see in conducting practical science activities?
3. Tell me about how the syllabus influencing you in planning and organizing practical activities for your students?
4. Tell me about what works well and what doesn't work well when you plan or organize practical activities for your students?
5. How do you assess your students when they are doing practical science activities?

Photo Elicitation-Interview question

1. Can you tell me about the photos you have taken and why? Your story will enable us to make a carton commentary about the photos you have taken.