SCHOOL-BASED ASSESSMENT OF PRACTICAL WORK IN SCIENCE EDUCATION IN SOLOMON ISLANDS

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ABSTRACT

This study explored and documented the views of one science curriculum development officer and seven science teachers about science practical work and its assessment in the School-Based Assessment (SBA) for the Solomon Islands School Certificate (SISC). Science SBA is compulsory for all Form 4 (year 10) and 5 (year 11) students in Solomon Islands to undertake as internal assessment towards the SISC. The motivation behind the research questions for this study arose from literature discussions and my personal experiences associated with practical work, teaching, learning and assessment in science education.

Based on the interpretive paradigm, qualitative data was generated using a semi-structured interview technique, conducted on an individual basis with prior consent. The interviews were conducted in May 2009. Audio tape recording was used to record exactly what was said by the participants in the Pidgin and later translated, transcribed and verified in English. The analysis of the data was recursive with a rigorous thematic approach.

The findings indicated that participants' beliefs and views about the aims of science teaching and the roles of practical work were mainly related to the notion of science literacy, which is the main aim in the Solomon Islands science curriculum for Forms 4 and 5. However, the participants' views about the nature of science and assessment of practical work in the context of SBA were narrowly expressed. The findings indicated that the issues of reliability, validity and use of formative and summative assessments in relation to the theories of learning and the standardization of assessments for high stakes reporting are worth considering for a revision of the science SBA.

As such, this study suggested that coherence in the aims of science teaching, the roles of practical work and the design and implementation of the SBA is necessary. Also, the notion of science pedagogical content knowledge (PCK) is recommended, especially with regards to its inclusion in pre-service teacher education and ongoing professional development. This study was qualitative with a small sample limited to only eight educator participants. Hence, further research is recommended. This should specifically investigate students' perceptions in order to understand their standpoints on issues related to the science school-based assessment (SBA) for the Solomon Islands School Certificate (SISC).

DEDICATION

This thesis is dedicated to

my mother, Mary Kakai, and my late father, Peter Kakai (Senior)

For their unconditional love with unfading support and blessings

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First and foremost I need to thank and give glory to the
'Aofia Tofangana Mangaa', the Almighty Creator beyond the Universe.

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CHAPTER ONE: Introduction

1.0 Chapter Overview

This chapter provides the frame of reference to this study. Firstly, it describes the motivation which gave rise to the research questions. Secondly, the research purpose and questions are stated. Then the context of this study is described, followed by an outline of the significance of this study. Finally, an overview of the following chapters is outlined.

1.1 Motivation for this Study

My interest in this study arose from the literature discussions that underlie science practical work and its assessment, and from my seven years of experience in teaching secondary school science in the Solomon Islands. This included my experience in designing and implementing of practical work as assessment activities for Forms 4 (year 10) and 5 (year 11) science students in two Solomon Islands national secondary schools and from my experience in conducting and marking foundation physics students' practical work at the University of South Pacific (USP) Campus in Honiara, Solomon Islands for five years, and two years in designing and implementing practical work for Form 6 (year 12) physics students, for their Pacific Senior Secondary Certificate (PSSC) internal assessments.

My main interest for this study was related to the quality of school-based assessment (SBA) of practical work in science education, particularly, in the context of the Solomon Islands School Certificate (SISC). I decided to conduct this study given the ongoing review of Solomon Islands science SBA Schedule every two years. Also, the Solomon Islands national science curriculum was being reviewed starting at the beginning of 2004, but had yet to be finalized when this study was undertaken. The national curriculum review was shaped by the outcome-based and student-centred learning, underpinned by the social constructivist view of learning and education for all and for life (Ministry of Education & Human Resources Development [MEHRD], 2007a). I believed it was significant to investigate the views and experiences of Forms 4 and 5 science teachers and a science curriculum development officer about the science school-

based assessment for the Solomon Islands School Certificate in order to understand their viewpoints.

1.2 Purpose of this Study

The overarching purpose of this research was to explore and document the views and experiences of seven Forms 4 and 5 science teachers and one science curriculum development officer about the purpose, design and implementation of science practical assessment activities in the school-based assessment (SBA) for the Solomon Islands School Certificate (SISC). Using semi-structured interviews, this study generated qualitative data from the participants' beliefs and views about the aims of science teaching, scientific methods and the purpose of practical work as a baseline. This data was then used to interpret their views about the purpose, design and implementation of science practical work as assessment activities in the SBA for the SISC.

It is hoped that the findings of this study can be used to shape improvements in practical assessment activities in the SBA for the SISC and science education in the light of the ongoing science curriculum reviews in Solomon Islands.

1.3 Research Questions

This study was guided by these three research questions:

1. What are the views of the participants with regards to the purpose, design and implementation of science practical assessment activities in the SBA for SISC?
2. How do the participants view the science practical assessment activities in the SBA with regards to their beliefs and experiences in science teaching, learning and assessment?
3. What changes do the participants suggest for the design and implementation of science practical assessment activities for the SBA in Solomon Islands context?

The context of this study is outlined next.

1.4 Context of this Study

The context of this study is outlined in six subsections: (1) Solomon Islands as a country; (2) Solomon Islands education system; (3) Solomon Islands School Certificate (SISC); (4) Science School-Based Assessment (SBA); (5) the rationale and (6) other influences that shaped the design and implementation of SBA.

1.4.1 Solomon Islands

This study involved eight participants from four secondary schools and the Solomon Islands Curriculum Development Centre (CDC) head office. The four secondary schools and the CDC head office are located within Honiara, the capital city of Solomon Islands. Solomon Islands is a small nation located in the Western Pacific region with other Melanesian Island Nations. It comprises six main islands and nine hundred and ninety two smaller islands. It is the third largest archipelago in the Oceania region, with a coastline which stretches over 5,313 kilometres and land mass of approximately 27,986 square kilometres (Honan & Harcombe, 1997).

Solomon Islands archaeological excavation and languages suggest that most of the country's descendents were from the Neolithic Austronesia speaking people who migrated from Southeast Asia in 1000BC (History, 2008). In 1567, the first European, Alvaro de Mendana from Peru in South America, discovered Solomon Islands during his search for the legendary isles of King Solomon (History, 2008). The United Kingdom declared Solomon Islands a British Protectorate in the 1800s. In 1978, Solomon Islands gained its independence and remains part of the Commonwealth. It has a democratic government with a constitution that was heavily influenced by the Westminster form of one legislative chamber (History, 2008). In 2000, the country went through ethnic tension between two islands which led to an intervention by an Australian-led Regional Assistance Mission to Solomon Islands (RAMSI) in June, 2003 (History, 2008).

The total population of Solomon Islands for 2009 was estimated to be around 595,613 people, with Melanesians (94.5%) who generally inhabit the larger islands; Polynesians (3%), occupy most of 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.

There are about 86 different languages spoken within the nine provinces across the country. Solomon Islands Pidgin commonly known as 'Broken English' is the national vernacular while English is regarded as the official language (CIA, 2009; Honan & Harcombe, 1997).

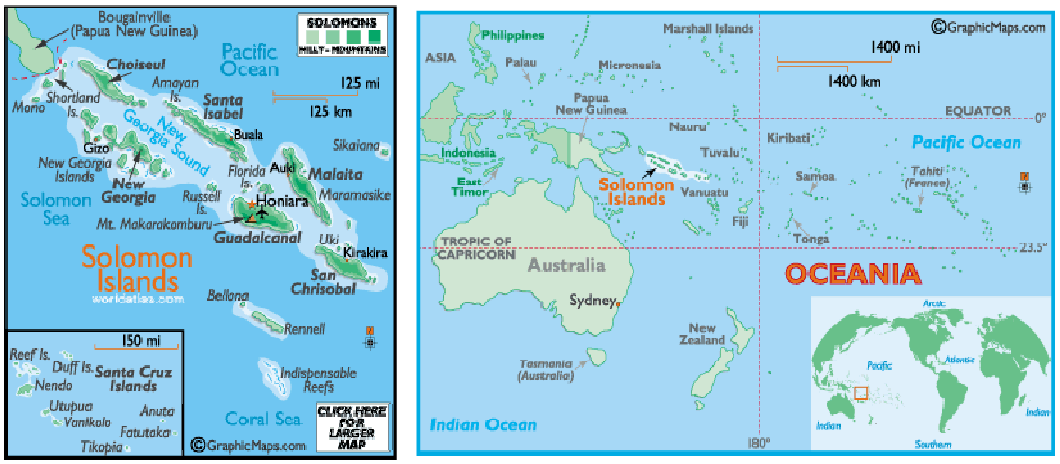

Figure 1.1. Map of Solomon Islands on the left, position 8 00 S and 159 00 E, in comparison to the Oceania region and the world on the right (Graphic maps, n.d.).

1.4.2 Solomon Islands Education System

Prior to formal education (a foreign concept), the traditional way of transmitting skills and knowledge in Solomon Islands societies was through social interaction between the young novices and the expert elders in real life situations. Such transmission was seen as a way of preparing the young ones for ongoing development and future endeavours, as they would actively participate in all aspects of their social, political, economical and technical lives in the traditional Solomon Islands context and societies.

Formal education was introduced in the late 1800s and early 1900s by missionaries and labour traders (History, 2008). The British Solomon Islands Protectorate Government (BSIP) basically encouraged churches to take active role in providing education in the country during those early years. However, according to Kii (as cited in Sade, 2009), the first Department of Education was established in 1946 with a strong collaboration and cooperation for educational development with mission schools. That understanding is still evident in the Solomon Islands education system today, with most of the schools operated and

administered by churches although they are subsidized by the government by way of teachers' salary and annual grants (MEHRD, 2007b).

Currently, the Solomon Islands' education system consists of five types of schools (MEHRD, 2007c). Two types of schools are the Early Childhood Education (ECE) and Primary Schools. The other three types are Community High Schools (CHS), Provincial Secondary Schools (PSS) and National Secondary Schools (NSS). There were 9 NSSs, 16 PSSs and 117 CHSs in 2005 (MEHRD, 2005a).

The national secondary schools are originally high schools operated by the government and the churches with student enrolments from all over Solomon Islands. The provincial secondary schools were initiated by the government in 1976 for the training of vocational skills but between 1982 and 1985 they adopted the NSS syllabus and were run by the provinces with student enrolment restricted to respective provinces. The community high schools were started in 1995 as part of primary schools to cater for many standard six students going into secondary education. They were built, and managed by different communities and assisted by the church or Provincial Education Authorities. They used the same syllabus as the NSS and PSS (MEHRD, 2007c).

Secondary school follows after primary education from Form 1 (year 7) with 13 year old students to Form 6 (year 12) with 18 year old students. A smaller number of students go on to do Form 7 (year 13) or foundation studies. There are two secondary school levels: junior secondary, consisting of Forms 1 to 3 (years 7 – 9) and senior secondary, consisting of Forms 4 to 6 then Form 7. This study was conducted with a sample of science teachers who were teaching in Forms 4 and 5 which offered the school-based assessment (SBA) for the Solomon Islands School Certificate (SISC).

The total number of teachers in secondary schools in Solomon Islands in 2007 was 1,288. The student-teacher ratios in 2007 for secondary schools, according to MEHRD (2007c), were 24.8 in CHS, 19 in PSS and 21.1 in NSS. Although there are no statistics on the number of science teachers teaching in Forms 4 and 5, other statistics can be used to make a comparison in terms of the size of the sample in this study. The total number of secondary schools that offered Forms 4 and 5 in 2007 was 142 (MEHRD, 2007c). According to my knowledge and

experience, there are usually an average of two science teachers per school teaching Forms 4 and 5. Therefore, it can be assumed that the total number of science teachers teaching Forms 4 and 5 in 2007 was about 248. This number can be used as an estimate for the number of science teachers in 2008 and 2009, out of which seven plus one curriculum officer were involved in this study. It can be assumed that this study involved about three percent of the science teachers in Solomon Islands who taught Forms 4 and 5 and conducted the SBA for the SISC.

1.4.3 Solomon Islands School Certificate (SISC)

Solomon Islands School Certificate is the recognized national secondary school certificate which is attained at the end of Form 5 in the Solomon Islands education system. It is directly administered by the National Examination and Standards Unit (NESU) under the Ministry of Education and Human Resources Development (MEHRD) of the Solomon Islands Government (SIG). SISC is basically a two year course which begins in Form 4 and is completed at the end of Form 5 the following year.

Entry into secondary school is highly competitive and the placements in upper secondary level are allocated on the basis of student's performance in the end of year examinations, with fewer available spaces at each more senior level of schooling (MEHRD, 2007c). To be eligible to enrol into Form 4, all junior secondary school students have to sit the Solomon Islands Form 3 National Examination (SIF3) at the end of Form 3. At the beginning of 2010, only 4,286 students out of the 6,001 students throughout the country who sat for the Solomon Islands Form 3 national examination at the end of 2009, will progress to Form 4 (MEHRD, 2010, January 15). Also, only 1,832 Form 5 students' will progress to Form 6 (year 12), out of the total of 3,281 students who sat for the Solomon Islands School Certificate (SISC) throughout the country in 2009, (MEHRD, 2010, January 13). These statistics suggest that 56 percent of the students who did the SISC progress to Form 6 whilst 54 percent may leave the formal education system. This gives an indication of what the Solomon Islands School Certificate and science education is addressing in terms of educating Solomon Islands youths in Forms 4 (year 10) and 5 (year 11).

The Solomon Islands School Certificate assessment consists of four core subjects and five elective subjects, giving a total of nine subjects. Basically, the core subjects are compulsory for all students in Forms 4 and 5. The core subjects include English, Maths, Science and Social Studies. The elective subjects are optional with the students' own preference to choose any two elective subjects commencing in Form 4 through to the end of Form 5. The elective subjects include Agriculture, Business Studies, Home Economics, Industrial Arts (now referred to as Technology) and New Testament Studies. This enables each student in Forms 4 and 5 to undertake and be assessed in six subjects; four core subjects and two elective subjects (MEHRD, 2005b).

The Solomon Islands school certificate assessment at the end of Form 5 is comprised of a national external examination for all nine subjects and internal school-based assessment (SBA) for five of the nine subjects. The subjects that have internal SBA are Industrial Arts, Agriculture, Home Economics, English and Science. However, the weightings for the components of assessments in each of the five subjects vary. For example, English has 70 percent in external examination and 30 percent in the SBA, whereas Science has 80 percent in the external examination and 20 percent in the SBA (MEHRD, 2005b).

1.4.4 Science School-Based Assessment (SBA)

The science SBA is made up of two components; nine Pupil Performed Assessment Practicals (PPAP) and one research project (*see Appendix A-section 3.0).* There are three pupil performed assessment practicals for each discipline (Physics, Chemistry and Biology) out of which, two are Common Assessment Practicals (CAP) and one is a Teacher Design Assessment Practical (TDAP) (*see Appendix A-section 4.0 & 5.0*). On the whole, the 100 percent science assessment marks for the SISC is comprised of 20 percent from the nine practical assessment activities with one research project and 80 percent from the science written external examination at the end of Form 5 (*see Appendix A-section 7.0*).

The 20 percent from the internal school-based assessment is comprised of 15 percent from the PPAPs and five percent from the research project. Each PPAP is worth 30 marks. That is, 20 marks for completing the report sheet after doing the practical assessment activities and 10 marks for the assessment of students' skills.

The research project is marked out of 40 marks which make up five percent of the 20 percent in the SBA (*see Appendix A-section 14.0*). Out of the total 40 marks, 30 marks are allocated to the written report and 10 marks are the possible marks for an oral presentation by each student (MEHRD, 2008).

According to the MEHRD (2008), Forms 4 and 5 science teachers were required to design three teacher design assessment practicals (TDAP), one for each science discipline (Physics, Chemistry and Biology). The TDAP allowed science teachers to design practical assessment activities according to their available resources. However, TDAP were expected to use the same format as the CAP with same marking criteria. Science teachers were also required to send their TDAP with a timetable for their SBA schedule to the CDC for approval or changes before they are allowed to implement them (*see Appendix A- section 4.0*).

The overall aim of the science school-based assessment for the Solomon Islands school certificate (*see Appendix A*) is to:

> assess the skills necessary to science which are difficult to assess in the written examination. These are practical and research abilities and it includes the following performance skills: Observations; Follow instructions to carry out an investigation with accuracy; record/collect and communicate data accurately; interpret data and respond correctly to questions related to the data and draw valid conclusions. (MEHRD, 2008, p. 1)

The marking criteria for each practical assessment activity are given in the SBA handbook. Each practical assessment activity has a report sheet which students need to complete during the activity and be handed in afterwards for marking (*see Appendix B*).

According to MEHRD (2008), teachers are advised to return marked practical assessment activities to students for consultation purposes only. They are required to keep all marked practical assessment report sheets from Form 4 until the end of Form 5 the following year. Then five best and five below average practical assessment report sheets will be selected and submitted as samples for the final moderation at the curriculum development centre by a selected panel of

moderators (*see Appendix A-section 17*). The practical assessment activities were conducted towards the awarding of the final grade in the SISC (MEHRD, 2008). Hence, the marked report sheets should not be given back to the students since the practical assessment activities are carried out for the Form 5 SISC assessments throughout Solomon Islands (MEHRD, 2008).

1.4.5 Rationale for Science School-Based Assessment (SBA)

The assessment of science practical skills was introduced in response to the findings from a study that was conducted by Fradd and Crawford (1986). Both were former expatriate teachers at King George the Sixth (KGVI), a state National Secondary School owned by the Solomon Islands Government under the Ministry of Education. Their study was conducted to investigate the claim that most Solomon Islands students who did Form 6 and Form 7 science performed poorly with regards to science practical work in tertiary studies. Moreover, it was claimed that the students did not have the attitude to work independently and consistently during the transition after attaining Solomon Islands School Certificate (SISC) to Form 6 through to Form 7, more so at the tertiary level (Fradd & Crawford, 1986).

The Fradd and Crawford (1986) study reported that Solomon Islands students lacked practical skills. Their findings also suggested that the poor performance by Solomon Islands students was due to the lack of exposure to the kind of teaching, learning and assessment approach which was supposed to develop the adequate science practical skills and the attitude for consistent self directed learning.

Subsequently, in the early 1990s the assessment of science practical skills was introduced in science for the Solomon Islands School Certificate (SISC). Initially, the assessment in science for the SISC was composed of two separate one-shot external examinations at the end of Form 5. One was for assessing science practical skills and the other was for the written external examination. However, due to criticisms against one-shot examinations of practical skills in science, school-based assessment was later introduced in line with the Forms 6 and 7 science courses adopted from the South Pacific Bureau for Educational Assessment (SPBEA) and the University of the South Pacific (USP) respectively. The SPBEA administered the Pacific Senior Secondary Certificate (PSSC) offered

in Form 6 and USP College of Foundation administered the Form 7 courses. Comparatively, both of the science assessments for the PSSC and the USP foundation science involved science practical work as internal continuous assessments.

Subsequently, the findings by Fradd and Crawford (1986) and the trend of assessment strategies adopted in Form 6 and 7 science courses led the Ministry of Education through the Solomon Islands Curriculum Development Centre (CDC) to review and employ internal continuous assessment of students' science practical skills towards Science for the Solomon Islands School Certificate in the late 1990's. However, students' practical skills cannot be examined adequately using written tests and examinations. Hence the need to assess students' science practical skills through science practical activities in school-based assessment was seen by many science teachers and educators as significant to have some balance (MEHRD, 2008). Its introduction was also seen to drive science teachers to plan, prepare, conduct and implement science practical work as part of their teaching approaches and activity in science teaching, learning and assessment (*see Appendix A-section 4.0*) (MEHRD, 2008).

1.4.6 Other Influences

The current school-based assessment (SBA) design adopted in the Solomon Islands School Certificate (SISC) was mainly influenced by South Pacific Bureau for Educational Assessment (SPBEA) with a similar approach to Pacific Senior Secondary Certificate (PSSC). This was part of SPBEA's initiative to support and improve continuous assessment practices in the Pacific which was intended to improve student achievement. As such, technical assistance was also provided by South Pacific Bureau for Educational Assessment (SPEBA) which enabled writers at the Solomon Islands Curriculum Development Centre (CDC) to design the science practical assessment activities.

In the 10th Education Development Framework (EDF) Regional Indicative Program Concept Paper, the South Pacific Bureau for Educational Assessment [SPBEA] (2008) claimed that:

> Majority of teachers, curriculum advisors...in the Pacific islands do not have the adequate skills in effective assessment

> methodology. As a result, learning in the classroom is generally assessed through a series of written examinations, which inevitably, only test the cognitive learning experience. (p. 2)

The SPBEA claimed that the traditional ways of using written examinations cannot effectively assess the learning of essential life-skills. SPBEA identified that one of the problems was the attitude and the perception of teachers about assessment as being solely written tests for ranking purposes. As such, over the years SPBEA has worked closely with its member countries to develop strategies for assessment for learning or formative assessment strategies.

Given these contexts, the significance of this study is now outlined.

1.5 Significance of this Study

In the twenty years since the Fradd and Crawford (1986) study, school-based assessment of practical skills has been implemented and has gone through a few changes. However, there has been some criticism of it. This includes, how it was designed and implemented in different schools throughout the Solomon Islands, especially with regards to the lack of science resources, teacher qualifications and lack of coherence with other regional assessment strategies, such as the Pacific Senior Secondary Certificate (PSSC) from the South Pacific Bureau for Educational Assessment (SPBEA) and Foundation Science Certificate from the University of South Pacific (MEHRD, 2007d). From my own experience, I was concerned about the quality of assessment done in the school-based assessment in coherence with the aims of science curriculum, and theories of learning.

That said, the National Curriculum Reform Program in Solomon Islands aims to develop a curriculum which promotes the achievement of learning outcomes and provides the basis for continuous school-based assessment in all subjects at both primary and secondary education levels. This was indicated in the Solomon Islands Education Strategic Framework 2007-2015 (MEHRD, 2007b) and it is in line with educational assessment strategies proposed in the Pacific Education Development Framework (PEDF) (Pacific Islands Forum Secretariat, 2009).

The current assessment policy issues in Solomon Islands education aims to address a balance between different purposes of assessments which include:

> assessment for learning...; assessment to monitor and report on progress...; assessment for selection for further study or limited places...; and assessment for the purpose of providing a summarised report and feedback on student learning that has been achieved. (MEHRD, 2007b, p. 35)

In order to document the problems and concerns for the next science SBA review and the current review of the Solomon Islands national science curriculum, research was needed on the views of the current science teachers and the curriculum development officer. Their views would provide contextual understanding in relation to the issues surrounding the purpose, design and implementation of school-based assessment which can be relevant to all other subjects in the Solomon Islands National Curriculum framework.

1.6 Overview of the Other Chapters

This chapter is followed by Chapter Two, the literature review. Then Chapter Three discusses and describes the research design that underpinned this study. That is followed by Chapter Four which outlines the findings of this study. Chapter Five discusses the findings in comparison to the literature review and my own interpretations. Finally, Chapter Six draws the conclusion and highlights the implications and limitations of this study, also outlining some considerations for future research.

CHAPTER TWO: Literature Review

2. 0 Chapter Overview

This chapter reviews the literature on science education, practical work, assessment and school-based assessment (SBA). Firstly, it discusses the trends of reforms and the aims of science education and subsequently explains the nature of science and scientific methods. Then the concepts of practical work, assessment and SBA are discussed followed by an examination of the issues surrounding the quality of educational assessment in relation to reliability and validity of formative and summative assessments.

2.1 Trends in Science Education

Science education, including the teaching and assessment of practical skills in the western world, has gone through many changes and inevitably will change over time (Bell, 2007; Wellington, 1998). So, it is significant to explore and scope the trends in science education which have shaped the nature of practical work and its assessment. Apparently, curriculum changes in the developing economies were generally influenced by the trends from developed economies (Gray, 1999).

2.1.1 Three Waves of Science Education Reforms

According to De Jong (2007), there were "three main waves" (p. 15) of reforms in science education in the United States of America. Similarly, Wellington (1998) mentioned three main movements in practical work in the United Kingdom which he called three "phases or fads" (p. 4). These waves of reforms in science education also swept through New Zealand and Australia (Haigh, France & Forret, 2005). According to De Jong (2007), the three waves of reforms were influenced by three main waves of psychological theories of learning in education as well as political, technological and economical impetuses.

2.1.1.1 First Wave of Science Education Reform

The first wave of reform in science education occurred in the 1960s (Atkins & Black, 2003; De Jong, 2007; Duschl, 2008; Wellington, 1998). It was a political perception in the western world in reaction to the launching of the Sputnik by the

Soviet Union into an orbit around the world. The focus was on the development of students who would think and experiment like scientists. This view was scientist-oriented, a "pipeline model" (Aikenhead, 2006, p. 1) which aimed to prepare students for specialised science related careers. It was the inception of the notion of science education for national development (Drori, 1998). This perspective influenced the formation of the National Science Foundation (NSF) in the United States (Atkins & Black, 2003) and the Nuffield Foundation programmes in the United Kingdom (De Jong, 2007; Wellington, 1998).

The reform was also influenced by the behavioural and developmental learning theories in education (De Jong, 2007). The behaviourist perspective assumed learning occurred by conditioning learners to a particular stimulus which resulted in a particular learning response. As such, learners were given instructions for a series of activities and later followed up with feedback to their responses by marking their work (Biddulph & Carr, 1999); that is "paper and pencil testing of individuals" (Atkins & Black, 2003, p. 100). This theory also assumed that learning involves the merging of small pieces of mastered knowledge into one coherent larger piece of knowledge. As a result, complex concepts were broken down into simple component parts (Biddulph & Carr, 1999). With the developmental learning theory, learning was assumed to occur in the development of cognitive stages (Piaget, 1977). That means learning and intellectual development were considered to progress through succession of stages, determined by the age of the student (Biddulph & Carr, 1999). However, these views failed to distinguish performance of skills and learning of concepts. Moreover, they fail to explain why individual learners respond differently to different tasks or activities (De Jong, 2007).

2.1.1.2 Second Wave of Science Education Reform

The second wave of reform occurred in the 1980s (De Jong, 2007; Duschl, 2008; Wellington, 1998). This reform was mainly influenced by the theories of discovery learning and personal constructivism (De Jong, 2007). These ideas were an expansion to the theory of cognitive development by Piaget and they focused more on the learning process within the learner. Wellington (1998) termed this phase as the "process approach" (p. 4) in practical work. With discovery learning,

students were seen to construct their own knowledge based on new information and data collected by them in an explorative and inquiry learning environment. This resulted in the ideas encompassing hands on experiments and laboratory work where students had to follow the processes of 'discovery' (De Jong, 2007) to acquire scientific knowledge and skills. According to Wellington (1998) and Hodson (1998), this was a distorted view of science inquiry where experiments or laboratory works were theory-free. Science students were viewed as learners who could develop or discover science concepts by doing practical work. The existing knowledge and experiences of the students were not taken into account in this view of learning practical skills.

The personal constructivist view of learning theorised that learners can construct individual meanings and perceptions in connection to their existing schema which make up their personal construct. Hence, "individuals were seen as being able to change their own thoughts and actions" (Bell, 2005, p. 29). This change takes place when learners accept the external information into their existing schema or reorganise their existing schema to accommodate the external information (Illeris, 2002). That is, an individual learner can generate new understanding of the world by assimilating and accommodating new information into his or her existing mental structure or schema (Piaget, 1970, as cited in Hung, Mui, Wah & Ching, 2003). However, this theory did not consider the social construction of knowledge.

The two learning theories also stimulated the idea of learning phases in science practical work such as exploration, conceptual invention and application, and the introduction of essay writing in laboratory reports (De Jong, 2007). For example, in laboratory exercises students would do a pre-designed science practical by following instructions as recipes. Then they would write a structured report in analysing and explaining the phenomenon that they, themselves, had investigated. In that way, teachers could assess the students' learning by reading their constructed report. However, these views were seen to distort science learning since it separated skills and processes from content knowledge (Wellington, 1998).

2.1.1.3 Third Wave of Science Education Reform

The third wave of science education reform was influenced by the social constructivist view of learning which was then followed by the socio-cultural perspective (De Jong, 2007; Duschl, 2008).

The social constructivist perspective was a response to the criticisms of personal constructivism which "ignored the socially and historically situated nature of knowing" (Bell, 2005, p. 40). With this perspective "cognition is seen as involving the mind, a social process, and not just the cognition about social processes" (p. 41). It included Vygotsky's idea of putting emphasis on the construction of knowledge through social interactions that are influenced by history, language, culture and situation (Biddulph & Carr, 1999). Students were given more opportunity to take increasing responsibility for their own learning within their own social context, as well as, being involved in reasoning and making contextual meanings of science concepts (Haigh & Hubbard, 1997). Furthermore, there was an increased focus on using assessment to improve learning and giving feedback and feedforward to improve learning outcomes (Bell & Cowie, 2001).

The socio-cultural perspective of learning regarded education as a culture. Hence, learning was considered as an enculturation process where learners "change from one socio-cultural environment, usually everyday life experiences and knowledge, to a new, scientific environment, including a change of language" (De Jong, 2007, p. 17). It theorised that teaching, learning and assessment are purposeful, intentional, situated, contextual, and collaborative activities which use language to communicate meaning (Bell, 2005). So scientific knowledge should be represented in a meaningful language and be of value in the context of people's everyday lives in their democratic societies (Hodson, 1998).

During this reform, open investigations were introduced with problem-solving tasks which enhanced students' development in making links between science concepts and procedures, as well as promoting the nature of science which involves socio-cultural processes (Haigh et al., 2005).

2.1.2 Current Trend in Science Education

The current debate in teaching and assessment of science in the western world is strongly revolving around the notion of science literacy (Duschl, 2008; Gilbert, 2003; Hodson, 1998; Laugksch, 2000). Science literacy is not related to 'literacy' and 'numeracy' in the sense that students are able to read and write in science. Rather, it relates to scientific literacy which addresses the ability of a science student to understand and be aware of scientific knowledge, skills and activities and their influences on the society in everyday context (Zen, 1992). This notion amalgamates the contemporary perceptions in science with socio-cultural views of learning and takes into account the effects technology, politics and society have on scientific knowledge and vice-versa (Hodson, 1998; Laugksch, 2000). This is synonymous with the aims of science education which focuses heavily on how scientific knowledge is related to the democratic society that has been largely shaped by science and technology (Hodson, 2003). Subsequently, science literacy has influenced the exploration of the purposes for science education in many western countries and globally as a whole. It has been an international and a well recognised slogan (Laugksch, 2000). Science literacy is also emphasised in the Solomon Islands Science Curriculum (MEHRD, 2007a).

2.1.2.1 Aims of Science Education

According to Atkins and Black (2003), science education should reflect and transmit the values, wisdom and knowledge that prevail in a particular time as desired and, expected by stakeholders, public and other political interests. This means that the purpose for science education is multiple, depending on different expectations and perceptions held by different stakeholders. Nevertheless, currently, the aims of science education can be summarized as having two distinct aims. They are for selection into higher education levels and career paths and for science literacy (Hodson, 1998; Millar, 2004). With the second notion, the overarching purpose in science education can be summarised according to three learning elements discussed by Hodson (1998). Those are (1) 'learning science' to acquire and develop conceptual and theoretical knowledge; (2) 'learning about science' to develop understanding and to be aware of the complex interactions that science has with technology, society and environment and to value its history

and development; and (3) 'doing science' to engage in and develop inquiry and problem solving skills. That is, to develop understanding in the nature of science. These three learning elements, according to Hodson (1998), focused on developing students to use science in their everyday contexts as educated citizens. According to Sadler and Zeidler (2009), this is a move that takes into the account the socio-scientific issues and which "highlight learners' use of science in real-life contexts" (p. 909) and not only in science-based careers and occupations.

Duschl (2008) highlighted that 'Science for All' in the United States and the 'Public Understanding of Science' in the United Kingdom is an educational goal "to develop a scientifically literate populace" (p. 268). In the New Zealand curriculum, one of the main reasons given for students studying science is for them to develop and "use scientific knowledge and skills to make informed decisions about the communication, applications of science as these relate to their own lives and cultures and to the sustainability of the environment" (Ministry of Education, 2007, p. 28). Similarly, the rationale for science education in Solomon Islands is:

> Achieving a better future for Solomon Islands will become a reality through improved scientific literacy levels of everyone and a sound understanding of the nature of science; matter and energy; life and living; earth and space; and traditional and contemporary scientific knowledge. Skills in science provide learners with a foundation for better living, whether it be in their community or through further education or formal work. (MEHRD, 2007a, p. 1)

The emphasis in science education is more on developing the ability of a science literate person to participate in, and to actively engage and contest science-related issues in a technological and democratic society. That is, to use scientific knowledge in problem solving, and decision-making concerning issues in a social context (Gilbert, 2003). For example, matters concerning societal issues such as global warming, health and HIV-AIDS, ICT and environment sustainability.

Laugksch (2000) claimed that due to the diversity in societies, the multi-dimensional aim of science literacy depends on the context in which it is used.

However, De Boer (2000) argued that the underlying intention in science teaching for science literacy is for students' personal enhancement for life in a changing society. Such intention in science teaching, learning and assessment has shifted the focus of learning from the learning of the 'what' towards learning the 'how' and 'why' of science (Duschl, 2008). This shift puts more emphasis on students' conceptual, contextual and procedural understanding of the nature of science to develop the ability of being responsible citizens by making informed decisions in many aspects of their everyday lives. This makes science education holistic in nature (Hurd, 1998). This shift redirects "attention to the design of learning environments as epistemic communities of practice" (Duschl, 2008, p. 277) where teaching, learning and assessment is integrated within the dimensions of cognitive, affective and social processes. The aim here is to "engage students in the epistemological aspects of science authentically" (Ford & Wargo, 2006, p. 134). But this move according to Handelsman, Miller and Pfund (2007) requires science teaching to posit the true nature of science. This ultimately depends upon the forms of instruction and assessment that make epistemological aspects of science apparent (Ford & Wargo, 2006). Therefore, it is important to explain the nature of science and scientific methods.

2.1.2.2 Nature of Science and Scientific Methods

Although there is no simple or an absolute definition for the nature of science, there are agreed common characteristics (Parkinson, 2004). Leach (1998) explained that the nature of science relates to the kind of epistemology and sociology of science within scientific communities. In other words, the nature of science depicts how scientific communities interact as individuals and groups in order to formulate and construct scientific knowledge and processes. For Millar (2004), the understanding of the nature of science encompasses:

> the understanding of how scientific enquiry is conducted, of the different kinds of knowledge claims that scientists make, of forms of reasoning that scientists use to link data and explanation, and of the role of the scientific community in checking and scrutinising knowledge claims. (p. 1)

Akerson, Cullen and Hanson (2009), Parkinson (2004) and Wellington (1998) outlined a list of the characteristics that can be used to describe and understand the nature of science. Nevertheless, I will only highlight some of the common characteristics which focus on the role of experiments and laboratory work.

According to Parkinson (2004), one of the features of the nature of science is the understanding that scientific knowledge is understandable and reliable but also tentative and subject to change at any particular time. He also stated that scientific knowledge requires evidence and its validity is usually enhanced by precision in techniques and instruments used whether in confined or natural settings. He said that the processes in constructing scientific knowledge can be messy and most of the time had to go through many rigorous phases. In addition, Wellington (1998) asserted that science does not have one method. He said that "no scientific method follows a set, algorithmic procedure or a set of rules" (p. 9). Instead, science has methods and these methods involve "tacit, implicit and personal knowledge" (p. 9). He further asserted that experiments in science are mainly derived from some sort of theory and not vice versa. He also claimed that scientists are just ordinary people who have personal attitudes, opinions and prejudice but are creative and "work in social, cultural, historical and political contexts" (p. 10). As such, science as an enterprise has individuals who normally work in communities or institutions. They work in different disciplines of science which differ greatly from one another in what phenomenon they investigate and in how they carry out their activities. However, there is an exchange of techniques and conventional understanding among them about what makes a valid and reliable investigation in science (Parkinson, 2004; Wellington, 1998).

The understanding of these characteristics of the nature of science is important for science teachers in order to shape their beliefs and views about science teaching, learning and assessment (Akerson et al., 2009; Handelsman et al., 2007). In fact, an intervention study conducted by Akerson et al. (2009) on 17 K-6 elementary science teachers in Atlanta, USA, found that many of the teacher participants had narrow concepts or misconceptions about the nature of science prior to the intervention. They found that teachers' beliefs and views about the nature of science are significant to how the teachers approach their teaching and assessment in science. After the intervention, Akerson et al. (2009) found that many teachers

had changed their views and beliefs about the nature of science. That was reflected in how they taught their science classes after the intervention. However, they also found that some teachers made little changes to their approaches in teaching and assessment in science. They assumed it was because of other external factors such as the teachers' prior experiences and pre-service and in-service training. Hence, they recommended that the notion of the nature of science should be embedded in the pre-service and in-service teacher education and as part of a community of practice in schools and science classrooms.

The notion of a Community of Practice in schools and science classrooms is in line with the notion of establishing learning environments that integrated the dimensions of cognitive, epistemic and social processes (Duschl, 2008). Such learning environments can be applied in science classrooms and practical work. This involves socio-cultural interactions whereby both teachers and students dialogically experience the true meaning of the nature of science in science classes. Duschl (2008) suggested that such an approach promotes the cognitive, epistemological and sociological processes in science learning which in effect supports the idea of science literacy. That means the nature of science is not so much taught but practised as part of a learning environment. This requires new concepts and designs to science curriculum, instruction and assessment (Duschl, 2008).

The aims of science teaching, the nature of science and scientific methods outlined above are significant to this study. This is because teachers' understanding, beliefs and experiences on these three aspects of science education can lead to different views about the purpose for teaching, learning and assessment in science practical work (Millar, 2004).

2.2 Nature of Practical Work, Assessment and School-Based Assessment

So far, I have been using the terms 'practical work', 'laboratory work', 'experiment', and 'investigation' as they are used in different literature. However, for this literature review I will define and discuss the nature of practical work and explain educational assessment and school-based assessment. This involves

outlining their purposes with some pressing issues in the current trend of perspective in science education discussed earlier.

2.2.1 Practical Work

According to the literature, the terms 'practical work', 'laboratory work', 'experiment' and 'investigation' have distinct meanings but they may refer to similar activities and as such they may be used interchangeably (Hodson, 1998). Apparently, the term 'practical work' is commonly used in the literature associated with United Kingdom, Australia and New Zealand whereas, the term 'laboratory work' is frequently used in the North American literature and where laboratory work and "experiments are used virtually as synonyms" (Hodson, 1998, p. 153).

2.2.1.1 Definition of Practical Work

According to Woolnough (1994), 'practical work' is an overarching term covering a wide range of science activities in school science. This includes "any teaching and learning activity which involves at some point the students in observing or manipulating real objects and materials" (Millar, 2004, p. 2). Millar (2004) claimed that such science activities can take place in a school laboratory, classroom or outside of the school setting, at home or in natural settings. Actually, Abrahams and Millar (2008) preferred to use the term 'practical work' rather than laboratory work, because they claimed that science activities are not characterised by the location but the kind of things that students involve in when doing school science. For example, the Ministry of Education (1991) in New Zealand suggested that practical work in school science can include a wide range of activities such as creative writing, poster design, role play and debates which can take place outside the confines of a laboratory setting.

In addition, practical work can be regarded as any learning activity in science that encompasses learning by experience (Hodson, 1998). This is when students have firsthand experience in seeing, feeling and handling objects and organisms for themselves (Hodson, 1998). For example, he mentioned the students' experiences of seeing a bright light from burning magnesium; feeling the forces of magnetic repulsion and attraction; seeing the bending of light through a glass prism; seeing

microscopic organisms using microscopes and connecting simple electric circuits. He claimed that most of the phenomena that are addressed in school science do not usually occur in everyday life. Hence, providing an opportunity for students to directly experience these phenomena and events is seen to help them to have background frameworks to understand science concepts associated with their experiences.

However, practical work is not just about experiencing phenomena but also about thinking – a cognitive activity. With the Learning in Science Projects (LISP), researched at the University of Waikato, New Zealand, practical work was considered "as a thinking activity in which each participant constructed understandings, rather than solely the domain of the manipulative work of the hands" (Bell, 2005, p. 169). Hence, practical work is seen as both about the thinking processes, as well as, the handling of science equipment.

Hodson (1998) had noted that learning by experience encompasses students experiencing the procedural understanding of making meaning and constructing conceptual understanding in science. Conceptual understanding deals with factual knowledge, concepts, laws and theories of science while "procedural understanding has been used to describe the understanding of ideas about evidence, which underpin an understanding of how to proceed" (Glaesser, Gott, Roberts & Cooper, 2009, p. 597). Hodson (1998) suggested that practical work should "utilise a wide range of other active learning experiences such as the use of historical case studies, simulations and dramatic reconstructions, role playing and debating, computer based activities and thought experiments" (p. 149). This was also expressed by Gott and Duggan (2007). Such activities, according to Hodson (1998), provide opportunities for students to experience and to rationalize the messiness of science processes, as well as to understand the social events behind the phenomena and the construction of scientific knowledge.

In summary, 'practical work' is viewed as an overarching term which encompasses activities that provide students with the opportunity to learn by experience. Practical work also promotes students' cognition and the thinking which is involved in making meaning through social processes. Practical work provides science students with the opportunity to experience the nature of science

and this involves using a wider range of activities and not just laboratory work and experiments. So for the purpose of this literature review, 'practical work' is used as an overarching term. The term 'practical assessment activity' is used in this study to indicate practical work used for assessment purposes. However, terms such as 'laboratory work', 'experiments' and 'investigations' are used at times to emphasise its meaning and context. Whatever term is used, the underlying recognition in this study is that such activities provide opportunities for students' learning experiences in science. Basically, this study has investigated how the assessment of students' practical work can be improved in Solomon Islands science school-based assessment.

2.2.1.2 Purposes of Practical Work

Wellington (1998) stated that the purposes of practical work are for students' cognitive, skills and affective development. The cognitive purpose which corresponds with the aim of learning science (Hodson, 1998) is to teach the science concepts and theories by hands-on experience either by illustration or verification or observation. In line with the aim of doing science, the purpose of developing skills is to develop students' manipulative or manual skills, as well as to develop the procedural understanding in science inquiry (Hodson, 1996). The affective purpose is similar to learning about science which is to develop students' awareness about the nature of science, as well as, to make students motivated, excited and become interested and enthusiastic in science (Wellington, 1998). Practical work promotes the attributes of science literacy. That is, practical work helps students to see that the science ideas and skills used in constructing claims in investigations can also be used in "deconstructing public claims" (Gott & Duggan, 2007, p. 272). This involves:

> looking back from the public claim to its origin, asking questions like: 'Could this idea be tested?', 'Could this set of observations and measurements, carried out in this way, *possibly* give reliable data on this question?' and 'Are there alternative explanations of the data?' The claim thus becomes a key element in bridging the gap between pupils' work in the school laboratory (or in the field) and claims about science in the media or other publications. (p. 272)

However, Gott and Duggan (2007) and Wellington (1998) recognised that the different purposes in practical work cannot be achieved in one single activity but would need different kinds of activities.

These different types of practical work would have different learning outcomes or purposes for science teaching and learning (Millar, 2004). So it is more important to identify the types of practical work and what learning they are intended to achieve. Currently, open investigations are used for senior students to experience and develop their understanding of science inquiry and the nature of science (Haigh et al., 2005). However, Millar (2004) explained that with multiple purposes the crucial point is the effectiveness of the practical work. That is, to ensure that the practical task is going to achieve what it is intended to achieve in terms of students' learning, learning about and doing science. Millar (2004) continued to argue that in order to assess the effectiveness of a particular practical work, its learning outcomes must be clearly identified and its design must be structured in such a way that students' attainment of the learning outcomes is visible and measureable.

2.2.1.3 Types of Practical Work and Learning Outcomes

To describe the different types of practical work for different purposes, Tamir (1991) used a continuum of level 0 to level 3. Teacher-directed activities such as teacher demonstrations and predesigned laboratory and experiments with predetermined outcomes are regarded as a level 0 practical work, since students are given specific instructions to follow. This form of activity is sometimes called "cookbook" (Llewellyn, 2005, p. 68) or "recipe practical work" (Haigh et al., 2005, p. 219). On the other hand, activities in which students take the central responsibility in identifying and deciding how to plan and carry out an investigation by themselves with the teacher's guidance is considered as a level 3 practical work (Tamir, 1991). This is what Llewellyn (2005) calls "student-initiated inquiry" (p. 66) or open investigation.

According to Millar (2004), practical work which is intended to teach science content might include learning outcomes such as to help students to (1) identify objects and phenomena or become familiar with them or (2) learn facts, concepts, relationships and theories in science. With these learning outcomes, practical

work "does not have to be authentic or similar to our idea of what real science is like" (p. 17). The first learning outcome can be easily achieved by students. For example, students may be able to identify and recall different types of objects or can describe a phenomenon either through teacher demonstrations, video or hands-on activities. However, learning outcomes such as to learned concepts, relationships and theories require scaffolding from teachers because they are about communicating an idea while it is being experienced, visualised and an understanding constructed by students (Hodson, 1998).

Scaffolding for such a cognitive learning outcome involves teachers addressing students' prior knowledge which is contextual to students' background and is influenced by their socio-cultural milieu (Duit & Treagust, 2003). According to the socio-cultural views of learning, students as individuals have different contextual backgrounds which are influenced by their everyday socio-cultural environment. This includes students' socio-cultural interactions and artefacts, political, historical, economical, geographical, language and religious backgrounds (Duit & Treagust, 2003). So students have preconceived ideas and conceptual frameworks related to the world from their everyday experiences. Hence, in order to facilitate the restructuring or the reconstruction of students' prior conceptual framework, the scaffolding in the practical work requires contextual links between what is already experienced and the intended science concept and skills to be learnt (Millar, 2004). So, for effective teaching of science concepts in practical work, scaffolding, learning and assessment tasks need to be purposeful, intentional, situated and collaborative using contextual language, artefacts and ideas to construct such links in order for the students to make a conceptual change (Bell, 2005; Vosniadou, 2002). Moreover, to ensure students' understanding of the science concepts, it is better to allow the students to apply the scientific concepts in different contexts or applications, which is also an avenue for students' enculturation into science (Hodson, 1998).

Another kind of practical work is open investigation. Open investigations are a type of practical work which contribute to students' learning about science and doing science (Hodson, 1998). Such activities were conducted for an intervention study in New Zealand in the 1990s. With open investigations, students were presented with a problem and then challenged to design their own plans to find the

solution (Haigh et al., 2005). The students worked individually and then collaboratively in groups to socially critique and analyse their designs and processes (Haigh et al., 2005). With open investigations, students are unaware of any correct answer and there are many routes to a valid solution. Collaboratively, "students reflect and modify their practice in the light of the evidence they have collected" (Glaesser et al., 2009, p. 596). That was a socio-cultural perspective. The intention in an open investigation task is to challenge the students to explore and extend their conceptual and procedural understandings in science inquiry and to experience the nature of science (Hodson, 1998). The value of such an intention is basically for the students to become familiar with the process in science inquiry and to develop their understanding about the basic epistemology of scientific knowledge (Osborne, 1998). However, Millar (2004) admitted that the effectiveness of such practical work can be difficult to assess since the learning "outcomes are rather imprecise and difficult to measure" (p. 3).

According to Hodson (1998), one form of practical work that can be effectively used to address some of the learning outcomes in practical work is computer simulation. Hennessy (2006) pointed out that simulations are idealised model invisibly programmed in computer software to represent real systems or physical phenomena. They are programmed such that students can actively interact with by manipulating certain variables and simultaneously observing the results. In fact, Michael (1997) explained that simulations may help students to observe and interact with some phenomena which are physically difficult to perform in their natural settings, for example, visualising the phenomenon of electromagnetic waves. Webb (2005) suggested that simulations incorporated with modelling software can help students to experience the nature of science and to understand the basic epistemology of scientific knowledge. That is, as Michael (1997) explained, in computer modelling, students are given complete control in constructing the system in the simulation. Students can interact with each other to construct the system beginning from their prior knowledge and scaffolding from the teacher. Such process provided similar challenges to those in open investigation with similar intentions (Webb, 2005).

However, such types of practical work require teachers to be competent scientifically and technologically. Moreover, the more complex the activity is, the

more difficult it is to be assessed, especially with addressing the issues of validity, reliability and manageability (Osborne, 1998). Hence it is significant to discuss the concept of assessment and how it is used in assessing practical work.

2.2.2 Assessment in Education

The main purpose of assessment in education is "making decisions about what is relevant evidence for a particular purpose, how to collect the evidence, how to interpret it and how to communicate it to intended users" (Harlen, 2005a, p. 207). Furthermore, the underlying principle of assessment in education is that it "must be understood as a social practice, an art as much as a science, a humanistic project" (Broadfoot & Black, 2004, p. 8). That means, the "decisions about who to assess and what to be assessed, for what purpose and by what method is a social practice which reflects a particular social context" (Broadfoot & Black, 2004, p. 8). For Bell (2007) assessment is part of the political enterprise of education with different shareholders. Hence, there is an increasing shift from psychometric testing to educational assessment which sees assessment in education as a social value. As such, she said shareholders outside the classroom have to be convinced in any decisions about assessment and the use of the assessment information. However, she claimed that most assessment in science education takes place in the science classrooms and it is the teacher and students who have the onus to generate the assessment information.

The assessment information generated in the classroom can be used for different purposes by different shareholders. The purposes of assessment are now discussed.

2.2.2.1 Key Purposes of Educational Assessment

The purpose which a particular assessment is intended to achieve at a certain time in a given social context can be used to categorise the types of assessment in both education and science education. Research into assessment in science education at the University of Waikato, New Zealand in the 1980s and 1990s indicated that assessment in both education and science education was increasingly for multiple purposes (Bell, 2005). The purposes of assessment have increased because different shareholders outside of the classroom wish to "use the assessment

information generated by teachers and students in science classrooms for different purposes" (Bell, 2005, p. 117).

There are three main purposes for assessment in education and science education (Bell, 2005). One is the assessment *for* learning, called formative assessment, which intends to help students learn and to *improve* teaching and learning. A second purpose is the assessment *of* learning, called summative assessment, which is intended to *prove* what learning has occurred by the students (Crooks, 2002; Harlen, 2005a; Harlen & James, 1997). A third purpose of assessment is accountability assessment which uses the assessment information from classrooms "to drive changes in practice and policy by holding people accountable for achieving the desired reforms" (National Research Council, as cited in Bell, 2005, p. 118).

"The terms 'summative', 'formative', and 'accountability' describe the purpose for which the assessment is done, not the task itself, as one assessment task might be used for both formative and summative purposes" (Bell, 2007, p. 969). Formative and summative assessments are discussed separately below with references to the assessment for accountability.

2.2.2.2 Formative Assessment

Bell and Cowie (2001) defined formative assessment as "the process used by teachers and students to recognise and respond to student learning in order to enhance that learning, during learning" (p. 8). Black and Wiliam (1998a) define formative assessment as "all those activities undertaken by teachers, and/ or by their students, which provide information to be used as feedback to modify the teaching and learning activities in which they are engaged" (p. 10). An activity may serve a formative function when it provides assessment information that can be interpreted to identify the gap between the actual levels of students' performance and the intended learning outcome. With such indication, appropriate actions can be taken by the students and teachers in closing the gap (Wiliam & Black, 1996). Formative assessment is defined according to what the assessment information is used for and not according to a particular or an inherent characteristic of an assessment activity (Dunn & Mulvenon, 2009).

Two aspects of formative assessment can be identified; planned and interactive (Bell & Cowie, 1999). Planned formative assessment involves the whole class whereas interactive formative assessment involves the interaction between the teacher and individual students. The planned formative assessment involves the teacher in conducting planned assessment activities, for example, brainstorming, to elicit assessment information which can be interpreted and used to improve the planned activities in science learning. This is mainly to address the intended learning outcomes required to be covered in the science curriculum. On the other hand, Bell and Cowie (1999) explained that interactive formative assessment involves the teachers in recognising and responding to individual student's learning needs during the teaching and learning process. This is mainly to address an individual student's learning and progress.

The important mechanism of taking action in planned and interactive formative assessment is the feedback and feedforward to the student from the teacher or another student (Bell, 2005). Feedback is defined as "information that gives the learner the opportunity to see how well they are doing or have done and what they might do next to enhance their performance and knowledge" (Cowie, 2005, p. 200). Subsequently, good feedback not only involves giving comments about what has been done but also feedforward for what can be done next. This includes teachers identifying student's strengths and weaknesses (Moreland & Jones, 2000), and giving advice to the student about how to improve and make adjustments in the next step during the teaching and learning process (Bell, 2005). According to Gibbs and Simpson (2004), quality feedback and feedforward can encourage and motivate the student in closing the gap between actual level of performance and what is intended to be achieved. The quality of feedback can also be judged in comparing the student's performance with "other students (norm referenced); standards or learning goals (criterion referenced), or the student's previous achievement (ipsative)" (Bell, 2005, p. 129).

There is an increasing trend in educational assessment towards the use of formative assessment in teaching and learning (Bell, 2007; Bell, 2005; Bell & Cowie, 2001). For example, Bell and Cowie (2001) asserted that policy documents on educational assessments in New Zealand have put more focus on formative assessment to indicate its importance in improving learning (Black &

Wiliam, 1998a). After reviewing 250 articles from 160 journals, Black and Wiliam (1998b) concluded that there was evidence that improving formative assessment does raise the standard of students' learning and performance. This was evident in one of the studies devoted to low achievers and students with disabilities (Black & Wiliam, 1998b). They noted that the study showed that frequent and ongoing quality feedback and feedforward helps both groups enhance their learning. However, Cowie (2005) recommended that if formative assessment continues to be a key element in New Zealand education assessment strategy then the socio-cultural aspects of students and teacher interaction in classroom is vital, especially when teachers are held accountable for students' achievement (Crooks, 2002).

Formative assessment may be theorised using the socio-cultural and social constructivist views of learning (Bell & Cowie, 2001). Likewise, the notions of scaffolding in enhancing conceptual understanding in practical work and developing the attributes of scientific literacy may also be theorised using the socio-cultural and social constructivist views of learning. As such, formative assessment is worth considering in the context of the assessment for conceptual learning in practical work and for science literacy. Subsequently, for the purpose of this research, formative assessment is viewed as a socio-cultural process of interaction during teaching and learning where feedback and feedforward between teachers and students, as well as students to students is an integral mechanism to address the learning gaps that students have. However, "formative assessment is a highly complex and skilled activity for both teachers and students" (Bell & Cowie, 2001, p. 79). Hence, quality of feedback and feedforward is a professional skill that teachers will develop over time in their professional careers and experience (Bell, 2005).

In the Solomon Islands, a baseline study conducted by Sade (2009) found that technology teachers tended to ask closed questions as a form of formative assessment. There was less feedback and feedforward since the teacher dominated the interaction. Similarly, another study conducted by Walani (2009) to investigate Solomon Islands secondary school teachers' views about formative assessment reported that, although teachers have some knowledge about formative assessment and its value in teaching and learning, implementing it was difficult in

the Solomon Islands education system. Both studies implied that this was due to teachers' narrow understanding of formative assessments and the heavily prescribed curriculum with time constraints to fulfil the school syllabus' learning outcomes. Summative assessment was more practiced in Solomon Islands classrooms.

2.2.2.3 Summative Assessment

Summative assessment is more concerned with summing up or summarising the achievement status of a student within a specific period (Sadler, 1989). For Harlen and James (1997) summative assessment describes the learning that is "achieved at a certain time for the purposes of reporting to parents, other teachers, the pupils themselves and, in summary form, to other interested parties such as school governors or school boards" (p. 5). Carr, McGee, Jones, McKinley, Bell, Barr and Simpson (2000) claimed that "summative assessment may also be used for public auditing and accountability of institutions and individuals, and for government policy review" (p. 64) in which case, it is also called assessment for accountability purposes. In addition, Carr et al. (2000) stated that summative assessment may take place on one occasion, such as external examinations at the end of an extended period or be continuous, such as periodic internal assessments by teachers throughout the year. Brown (as cited in Bell & Cowie, 2001) suggested that such continuous assessment can be regarded as a weak formative assessment.

The term 'continuous assessment' was also used by Carlson, Humphrey and Reinhardt (2003) in the United States. They referred to continuous assessment as a naturalistic assessment where assessment is embedded in the "natural setting of the classroom and involves observation of student performance in an informal context" (p. 2), rather than being embedded in commercial standardised tests. They described continuous assessment as, "the process of learning to be with children in such a way as to understand their thinking so that you can continually expand, challenge, and scaffold each child's experiences" (p. 1). That is natural formative assessment where scaffolding is ongoing and the learning process is continuous as a natural way of evaluating oneself within the context of the classroom setting (Carlson et al., 2003). This definition of continuous assessment is not what is referred to in this review.

In this review, 'continuous assessment' is defined in the context of continuous summative practices from which grades are aggregated at the end of the teaching period or year and can also be used for weak formative purposes (Bell & Cowie, 2001). Continuous summative assessment was in response to the criticism against one-shot summative assessments, such as end-of-year examinations. In addition, continuous summative assessment has resulted in the assessment of a wider range of learning outcomes such as practical skills in science, as well as the use of different assessment tasks over a certain period. Continuous summative assessment is also emphasised in school-based assessments (Bell & Cowie, 2001).

2.2.3 Concept of School-Based Assessment (SBA)

School-based assessment has been used in many countries, for example, Australia (Maxwell, 2004), Hong Kong (Yip & Cheung, 2005) and New Zealand (Crooks, 2002). However, although the implementation of school-based assessment in many countries differs, the underlying conceptions and purposes are similar, with a wide spectrum of characteristics. Hence it is important to describe school-based assessment and outline its purpose.

School-based assessment for summative purposes, also called continuous summative assessment, is defined as summative assessments undertaken by the teacher, rather than an examination authority outside the school, such as the New Zealand Qualification Authority in New Zealand (Crooks, 2002) and the National Evaluation and Standard Unit (NESU) in the Solomon Islands (MEHRD, 2005b). The summative assessment marks or grades are aggregated by the teacher and school. The final mark or grade maybe forwarded to a national agency if a national qualification, such as the National Certificate of Educational Achievement (NCEA) in New Zealand and the Solomon Islands School Certificate (SISC) in the Solomon Islands is to be attained.

2.2.3.1 Supplement to One-Shot External Examination

School-based assessment supplements the external examinations by providing a continuous measurement of students' abilities over an extended period of time (Yip & Cheung, 2005; Maxwell, 2004). School-based assessment with internal continuous assessments is seen as a valid assessment strategy since it is

"progressive or continuous" (Maxwell, 2004, p. 2). For instance, in Hong Kong, the external practical examinations of science subjects at the Advanced Level (AL) are replaced by the "Teachers Assessment Scheme (TAS)" (Yip & Cheung, 2005, p. 156). Teachers in each Hong Kong secondary school are responsible for assessing their students' practical skills over the whole Advanced Level course and the cumulative marks from the teacher-assessments make up 15-20% of the total subject marks. As such, school-based assessment "removes many of the disadvantages of a one-short external examination" (Yip & Cheung, 2005, p. 156) and alleviates the "peak pressure of a single final examination" (Maxwell, 2004, p. 2).

2.2.3.2 Assessment for Multiple Purposes

School-based assessment is used to address the multiple purpose of assessment, as well as to assess a wide range of learning outcomes. In New Zealand, school-based assessment is used to address the multiple purpose of assessment with multiple procedures (Bell & Cowie, 2001). As such, school-based assessment in New Zealand is used for "improving learning, reporting progress, providing summative information, and improving programmes" (Ministry of Education, as cited in Bell & Cowie, 2001, p. 4). School-based assessment can use various kinds of assessment activities to appropriately cover some of the learning outcomes that cannot be properly assessed in one of the written exams at the end of the course or the year (Maxwell, 2004). For example, the assessment of performance skills and procedural understanding in science, as well as the use of different forms of assessment such as, essays, portfolios, investigations, literature reviews and self and peer assessments.

2.2.3.3 Interactive Use of Formative and Summative Assessment

School-based assessment is believed to be a significant mechanism in addressing the duality concept of assessment, which involves both summative and formative assessment (Fok, Kennedy, Chan and Yu, 2006). The inclusion of school-based assessment in the public examinations of Hong Kong might be an example of "attempting to integrate 'assessment of learning' and 'assessment for learning'" (p. 2). The ongoing nature of school-based assessment can provide teachers with a formative view of the progress of each individual student and this would allow

teachers "to address more accurately the specific needs of their students" (Yip & Cheung, 2005, p. 156). Likewise, in the Singapore education system, school-based assessment is an integral part of teaching and learning because it provides feedback on pupils learning (Lim & Tan, 1999). In New Zealand there is growing recognition that school-based assessment addresses both the formative and summative purposes of assessment (Bell & Cowie, 2001). Having these similarities, school-based assessment is regarded in this review as a mechanism which provides the opportunity to utilise both summative and formative aspects of assessment concurrently and progressively.

2.2.3.4 Role of Teachers

The professional knowledge of teachers to effectively carry out school-based assessment is the main focus of attention in the light of using assessment for multiple purposes. The recognition of the role of science teachers in science teaching, learning and assessment is significant and "teacher knowledge was identified as the important factor" (Moreland, Jones & Cowie, 2006, p. 145). Shulman (1987) suggested that teachers as professionals should have subject content knowledge, general pedagogical knowledge, knowledge of curriculum and its underlying theories and philosophies, knowledge of learners' characteristics and their social and cultural backgrounds and pedagogical content knowledge (PCK). Pedagogical content knowledge (PCK) encompasses effective ways of transforming complex subject content into forms that students of diverse and unique abilities and socio-cultural backgrounds can comprehend (Moreland et al., 2006). That is, pedagogical content knowledge encompasses the teacher's understanding in connecting subject content, aims of curriculum, classroom pedagogy, and diversity of students and purpose of assessment (Park & Oliver, 2008). Science teachers should have a coherent knowledge about the aims of science teaching, the roles of practical work, the nature of science, pedagogy, students' ability, and the nature of assessment for different purposes based on different theories of learning.

With the assessment of practical work in school-based assessment, teachers play the most important role in designing, making decisions and carrying out the assessments of the students (Bryce & Robertson, 1985). Teachers are not only

involved in marking the completed written tasks done by the students but as a practical activity in science, they have to assess the students' performance (Bryce & Robertson, 1985). Teachers also use practical work to teach scientific knowledge and skills. Subsequently, they take the primary responsibility in assessing student understanding of the scientific knowledge and skills. Given these responsibilities, with the dual assessment purpose of school-based assessment, teachers' pedagogical content knowledge is increasingly a key element.

Sade (2009) found that Solomon Islands technology teachers in his professional development intervention study enhanced their pedagogical content knowledge in technology education. He found that the teachers changed their teaching and assessment practices for both formative and summative purposes in the classroom. However, he found that requirements in school-based assessment for summative purposes and accountability in technology education were seen as hindrances to teachers' changing their teaching and assessment practices. Assuming similar implications in science education, this study was conducted to investigate science educators' experiences and views about issues surrounding science school-based assessment that can be used to enhance the dual concept of assessment in Solomon Islands contexts.

However, although teachers are knowledgeable about school-based assessment and are given responsibility to assess their students in their respective schools, moderation is important to maintain the quality of assessment across different schools (Yu, 2009). This is because, although students are assessed on similar tasks with same assessment criteria, a teacher in one school may mark differently according to his or her own judgement compared to teachers in other schools (Yu, 2009).

2.2.3.5 Moderation

Australia and New Zealand have been using moderation methods for years. In New Zealand, the main function of moderation "is to ensure that different applications of standards remain within acceptable limits. In other words, moderation ensures that assessors remain within the national goal" (New Zealand Qualification Authority [NZQA], 1992, p. 8). According to the Board of Studies

in Victoria, Australia, moderation is the process of ensuring that the same assessment standards are applied to students from every school doing a particular study (Maxwell, 2006). In Queensland Australia, school-based assessment activities are moderated for quality assurance at the end of the study period. The moderation, according to Maxwell (2004) is not to compare the uniformity of the assessment tasks by teachers in each school but is a mechanism to compare the various assessments to a common specified standard for quality concerning their reliability and validity.

According to Maxwell (2006), the critical issue in moderating school-based assessments is to establish confidence in the assessment procedures, tasks and results, especially with regards to high stakes assessments. He asserted that, to have great confidence in school-based assessment, moderation is vital to monitor and approve "assessment procedures and judgements to ensure there is consistency in the interpretation and application of the performance standards" (p. 4). This is because, although teachers assess students on the same task with same marking criteria, teachers in different schools may have different impressions and interpretations of their students' assessment tasks (Yu, 2009).

Maxwell (2006) described four types of moderation systems. He noted that for high stakes assessments moderation is done externally by either an external moderator or moderation panel. Conversely, for low stakes assessments moderation is done by either assessor meetings or assessor partnerships (refer to Maxwell, 2006). In the case of Solomon Islands science school-based assessment, moderation is done by a panel of external moderators which may comprise a few selected science teachers and education officers.

2.2.3.6 Purpose for Science School-Based Assessment in the Solomon Islands

The overall purpose of the science school-based assessment in the Solomon Islands School Certificate is to summatively assess those skills (*see Appendix A-section 3.0 & 7.0*) necessary to science which are difficult to assess in the written examinations (MEHRD, 2008). There are no instructions in the MEHRD (2008) handbook which instruct teachers to provide feedback or for any form of formative assessment. The science school-based assessment in the context of this study is solely for the awarding of the final grade in the Solomon Islands School

Certificate, mainly for summative and accountability purposes. Moderation in the context of this study is mainly related to high stakes assessments (*see section 1.4.4 in Chapter One and Appendix A-section 17*).

2.3 Enhancing the Quality of Educational Assessment

As already discussed, practical work is an important component of science education because of its role in addressing the aims of science teaching such as, the nature of science and science literacy. However, the main concern is for the quality of assessments of the science learning that takes place with practical work in the context of SBA. Black and Wiliam (2006) attested that reliability and validity are two essential components for enhancing the quality of educational assessment.

2.3.1 Quality of Assessment for Formative Purposes

The quality of formative assessment is increasingly concerned with validity (Bell, 2007; Bell, 2005). Validity of formative assessment involves the level and form of formative assessment which supports the learning of the students to achieve a learning outcome (Green & Johnson, 2010). With activities in science teaching and practical work, the learning outcomes are for students to understand the content, contexts and develop skills in science (Bell & Cowie, 2001). As such, the validity of formative assessment is embedded in the assessment of the students' learning of scientific content, context and skills during the teaching and learning process so that students' prior misconceptions or misunderstandings can be corrected in closing the gap (Green & Johnson, 2010). Stobart (2006) also asserted that validity in formative assessment hinges on how effectively such learning and assessment takes place.

Trustworthiness is one of the notions that describe the validity of the actions that take place in formative assessment. Trustworthiness according to Bell and Cowie (1996) relates to someone that can be trusted in the classroom. Cowie (2000) explained that trustworthiness in formative assessment encompasses the trust and respect that students have towards their teacher in providing appropriate feedback and feedforward. Such trustworthiness can be demonstrated through students' willingness to participate and respond to the feedback and feedforward provided

by the teacher (Cowie, 2000). With trustworthiness, students may perceive formative assessment as a worthwhile process which is beneficial to their learning, motivates them and fosters effective social interactions.

For formative assessment, reliability is not a concern (Bell, 2007). In fact, Black and Wiliam (2006) argue that the issues of reliability are very different with formative assessments. They say, with formative assessments the evidence collected and interpreted from assessment tasks or during learning are purposely to guide and improve teaching and learning to achieve an intended learning outcome. The evidence from formative assessment is not used to generalise scores or to make comparison for consistency (Black & Wiliam, 2006). This is because formative assessment is contextually bound, which means what teachers and students say and do during feedback and feedforward depends on the context and it changes all the time. It is not constant over time. Hence, the issue of reliability is not of great concern in formative assessment and it is an inappropriate measure of quality.

2.3.2 Quality of Assessment for Summative Purposes

Dependability is a term used "to signify the overall judgement of quality for an assessment which may be influenced by both reliability and validity" (Black & Wiliam, 2006, p. 119). In fact, "the concepts of reliability and validity are not independent of each other in practice" (Harlen, 2005b). As such, they may have overlapping interpretations and consequences (Black & Wiliam, 2006).

For summative assessments, reliability is about consistency and accuracy in students' assessment scores, and results which can be dependable (Brookhart & Nitko, 2008). Consistency in summative assessment is about the assessment results more than the instruments. Consistency can be addressed when the same or different students do equivalent assessment tasks at the same or different times but still produce the same results. That also includes whether different teachers mark the same assessment task or equivalent tasks at the same or different times, in the same or different places (Brookhart & Nitko, 2008).

The principle of consistency is significant for both students and markers (teachers) (Black & Wiliam, 2006; Brookhart & Nitko, 2008; Green & Johnson, 2010).

Consistency in summative assessment can be affected by students themselves or the markers. Physical, mental and emotional conditions during assessments can affect consistencies in assessment results (Brookhart & Nitko, 2008). Consistency can be maximised by allowing the students to do similar or "parallel forms" (Black & Wiliam, 2006, p. 122) of assessment activities several times and using the average scores to gauge their true scores. Correspondingly, consistency for markers can be dealt with by carefully considering the marker's ability to assess the assessment tasks (Black & Wiliam, 2006). One of the ways to maximise the marker's consistency is by careful selection and training of markers. This is for the markers to have the similar understanding and do comparative marking with other colleagues in different locations (Green & Johnson, 2010).

Reliability of summative assessment can be enhanced by explicitly outlining the learning outcomes and the marking criteria of the assessment tasks to both students and markers (Green & Johnson, 2010). Teachers would have the same interpretation of the assessment results and students would also know and understand what they are assessed for. Moreover, the assessment activities and items used must be consistent with what is used and learnt in the classroom teaching and learning (Green & Johnson, 2010). When different teachers assess equivalent assessment activities independently at different times and places using the same marking criteria, they should come up with the same judgements and results (Green & Johnson, 2010). This would be so in the case of school-based assessment for summative purposes, where assessment tasks are done in different schools with different students and markers. With regards to continuous summative assessments in school-based assessment and practical work, the principle of consistency espoused by Green and Johnson (2010) is significant for reliability.

Validity of summative assessment is embedded in whether the assessment activity actually assesses what it theorised or intended to assess (Stobart, 2006). It is "essentially about fitness for purpose" (p. 134). However "validity is not a simple concept and various forms of it are identified according to the basis of the judgement of validity, including face validity, concurrent validity, construct validity, consequential validity" (Harlen, 2005b, p. 247). These forms of validity are fully explained by Harlen (2005b).

Validity of summative assessment lies in the design of the assessment (Green & Johnson, 2010). The assessment tasks can be designed such that students should be able to demonstrate what they are supposed to be assessed for, a form of 'construct validity' (Harlen, 2005b). The assessment activity and instructions must be familiar to both students and teachers and have been used during the teaching and learning process (Green & Johnson, 2010). Increasing validity by designing different forms of assessment to assess higher levels of thinking may decrease their reliability because some of these aspects are not easy to assess (Harlen, 2005b). In the case of school-based assessment of practical work, validity of design can be addressed by using the procedures and science equipment that are familiar to both the students and teachers since they have been using them during the teaching and learning in science. As well, different forms of designs can be used to assess higher levels of thinking but this may decrease the reliability for summative purposes. It is the purpose of the assessment that determines its dependability, and which addresses the interrelationship between validity and reliability (Harlen, 2005b).

Summary of Literature Review

Science education, practical work and assessment have gone through many changes over the years. The current trend calls for a paradigm shift in the design and implementation of science instruction and assessment. This shift is influenced by the socio-cultural view of learning which also shaped the aims of science teaching and roles of practical work towards science literacy. Educational assessment is increasingly seen as a social practice which advocates the use of assessment to improve learning more than to prove learning. The interactive use of these two purposes is encouraged in the concept of science school-based assessment. The quality of school-based assessment depends on its purpose, design and the professional expertise of teachers to implement it coherently with the aims of science curriculum, roles of practical work and assessment procedures. Hence, this study has been framed to investigate the views and experiences of science teachers' and a science curriculum development officer about the purpose, design and implementation of practical work in science school-based assessment in relation to the aims of science teaching. Next, Chapter Three describes and discusses the research design for this study.

CHAPTER THREE: Research Design

3.0 Chapter Overview

This chapter presents the research design of this study. Initially, it reiterates the purpose and the research questions, and then it discusses the conceptual framework and design which underpinned this study. Thirdly, it describes the procedures for data generation and data analysis. Subsequently, the ethical considerations are explained, followed by discussion regarding the enhancement of the quality and validity of this study.

3.1 Purpose and Research Questions

Cohen, Manion and Morrison (2007) claimed that, "research design is governed by the notion of fitness for purpose" (p. 78). Hence, they said it is the purpose that determines the researcher's conceptual framework which underlies the research design of a study. Similarly, Krauss (2005), Labree (2003) and Lather (2006) agree with this. Before explaining the conceptual framework and research design, it is fitting to reiterate the purpose and the research questions for this study.

The overarching purpose of this research is to explore and document the views and experiences of seven Forms 4 and 5 science teachers and one science curriculum development officer about the purpose, design and implementation of science practical assessment activities in the school-based assessment (SBA) for the Solomon Islands School Certificate (SISC). It is hoped that the findings can be used to shape improvements in practical assessment activities in the SBA for SISC and science education in Solomon Islands as a whole.

With this purpose this research was conducted to answer the following research questions:

1. What are the views of the participants with regards to the purpose, designs and implementation of science practical assessment activities in the SBA for SISC?

2. How do the participants view the science practical assessment activities in the SBA with regards to their beliefs and experiences in science teaching, learning and assessment?
3. What changes do the participants suggest for the design and implementation of science practical assessment activities for the SBA in Solomon Islands context?

3.2 Conceptual Framework

To explain the underlying conceptual framework for this study, I will first define educational research, since this study was undertaken within the field of education. Then I will go on to define three common research paradigms to align the notion of fitness for purpose. Thereafter, I will outline the theoretical underpinning the research design of this study.

3.2.1 Educational Research

Mutch (2005) distinguished educational research by "its focus – people, places and processes broadly related to teaching and learning – and its purpose – the improvement of teaching and learning systems and practices for the betterment of all concerned and society at large" (p. 18). Educational research also involves many studies that are related to issues in policy-making within the field of education (Donmoyer, 2006). It is a "more analytical practice, which focuses on the effort to produce valid explanations" (Labaree, 2003, p. 17). However, with such broad focus and emphasis, educational research is complex and contentious since there is no single framework for doing it (Labaree, 2003). Educational researchers need to go beyond the "Kuhnian notion of one-dimensional perspective" (Donmoyer, 2006, p. 30) or "commitment to a particular paradigm" (Krauss, 2005, p. 761), to investigate issues in education from different perspectives. It is agreed that educational researchers should be free to choose among different research perspectives to specifically legitimate the purpose of their research.

3.2.2 Paradigms

Educational research is usually classified under one of the three paradigms: positivist, interpretive and critical (Lather, 2006). These three paradigms, according to Patton's (1990) definition, are three distinct world views which provide three different conceptual frameworks or perspectives for how a researcher sees and makes sense of social reality and knowledge. These paradigms are a basic set of beliefs (Kuhn, 1970) that researchers hold to make claims about reality and knowledge. These "beliefs are basic in the sense that they must be accepted simply on faith" (Guba & Lincoln, 1994, p. 108). In other words, the three classes of paradigms are three basic sets of beliefs that researchers, by faith, can hold to make claims about reality and their researched knowledge.

The three basic beliefs are fundamentally based on different "ontological, epistemological and methodological assumptions" (Coll & Chapman, 2000, p. 12). These are the philosophical claims that a researcher makes about: "what is knowledge (*ontology*), how we know it (*epistemology*)..., and the process of studying it (*methodology*)" (Creswell, 2003, p. 6). In brief, Table 3.1 below provides a simple analysis which distinguishes the three different sets of philosophical assumptions that researchers can make about researched knowledge behind the three paradigms mentioned earlier.

Table 3.1

Different sets of philosophical assumptions

Assumptions	Positivist	Interpretive	Critical
Ontology	Knowledge is Objective/found/ Universal.	Knowledge is Subjective/constructed/ Multiple.	Knowledge is Subjective/ Influenced by power and politics.
Epistemology	Knowledge is verified and uncovered.	Knowledge is communicated, generated and interpreted.	Knowledge is collaboratively decided.
Methodology	Researcher observes and controls investigations. 'Quantitative data'	Researcher interacts to develop in-depth and multiple understandings. 'Qualitative data'	Researcher facilitates and encourages change. Mixed method approach.

Note. A summary of the three paradigms from Cohen et al. (2007) and Lather (2006).

3.2.3 Interpretive Research Perspective

This research is placed within an interpretivist paradigm. According to Cohen et al. (2007), interpretive research aims to understand how people make sense of their world because of the interpretivist belief that each person is different and they experience the world in different ways. This is unlike the positivist's belief of objectivity, where they believe that reality is universal (Cohen et al., 2007). According to interpretive research, social reality and knowledge is constructed, interpreted and experienced by people only when they interact with one another because of the assumption that people being social individuals are capable of constructing their own meanings for what they experience and are constantly making sense of their complex and dynamic socio-cultural situations (Creswell, 2003). So, to understand the subjective world of people, interpretive research attempts to understand local meanings and contextual interpretations by interacting with the people in their specific socio-cultural situation without disturbing its complexity (Borko, Liston & Whitcomb, 2007). Basically, its focus is to interpret the interpretations people make about their actions and interactions in a specific but complex socio-cultural environment, which is dynamic and is influenced by history, politics, economy, language, geographical settings, science and technology (Andrade, 2009).

According to Cohen et al. (2007), the construction of knowledge in interpretive research is characterised by the active interaction between the researcher and the participants. In such construction of knowledge, the researcher plays a significant role since he or she is the medium through which the constructed knowledge is interpreted and reported (Creswell, 1998). Nevertheless, the researcher's interpretations are subjected to the participants' interpretations and are supported with a high level of argument, rather than just presenting statistical or numerical characteristics as in positivist or quantitative research (Cohen et al., 2007). Furthermore, such a high level of argument also includes the explanations of the rationales surrounding the construction of the interpretations (Borko et al., 2007). As such, knowledge constructed in an interpretive study is determined by the researcher's interactions with the participants which in turn provide quality interpretation from the participants' own interpretations of how they make sense of their socio-cultural surroundings and activities.

Borko et al. (2007) say that, interpretive research concerning teaching, learning and assessment in the field of education is regarded as a "complex intellectual endeavour" (p. 5), especially with respect to students in the socio-cultural context of a classroom. Interpretive researchers turn their attention more to understand "how teachers made sense of the socio-cultural organisation of their classrooms and the learning and development of students" (p. 5). In other words, to develop understanding about a specific socio-cultural situation in classrooms with regards to teaching, learning and assessment, an interpretive researcher needs to capture the teachers' view about their own teaching and students' learning and assessment. The descriptions and interpretations constructed by the teachers are subjected to how each of them make sense of and experience the socio-cultural environments in their classrooms.

Given the explanation above, this study was conducted in a particular situation of a particular country, which was in science school-based assessment (SBA) of practical work in Solomon Islands. Its aim was to construct an interpretation with quality arguments on views about the purpose, design and implementation of practical assessment activities in science classrooms, specifically with regards to SBA in the Solomon Islands School Certificate (SISC). So, in order to provide a sincere understanding and subsequently present convincing explanations, I went and interacted with the participants on an individual basis at their locale to elicit individual views and experiences about the phenomenon investigated. I was also able to capture individual participant's beliefs, emotions and tacit norms which, to some extent, explained the rationale behind their views and interpretations. Therefore, by using the interpretive perspective, the purpose of this study was legitimated.

3.2.3.1 My Role as the Researcher

Hence, as an interpretive researcher, I was the primary instrument of data generation and the avenue by which the knowledge researched has been made comprehensible and reported (Creswell, 1998). I was directly involved with the participants in the process of data generation but at the same time I was sensitive to the participants (Borko et al., 2007). This is similar to the qualitative case study

in which "the researcher is integrally involved in the case" (Cohen et al., 2007, p. 253). One significant feature was my role as the researcher.

My role as the researcher was to construct my own interpretations by integrating the participants' multiple constructions shaped by their socio-cultural contexts (Andrade, 2009). So besides having the close interaction with the participants in capturing contextual and quality meanings, I also had the responsibility to construct a central and persuasive account of analysis that holistically included the participants' multiple views and experiences about the purpose, design, and implementation of practical assessment activities in the SBA for SISC. My obligation as an interpretive researcher was to present the knowledge constructed in a way that is intelligible to the readers. Moreover, the credibility of an interpretive researcher "depends on the ability and effort of the researcher" (Golafshani, 2003, p. 600). On the whole, my role as the researcher has been to construct and analyse meanings and explanations that are credible and trustworthy.

Nevertheless, Borko et al. (2007) suggest that, in interpretive research, the responsibility is also upon its readers to determine what power of explanation the study has within their own local contexts. Therefore, using the interpretive perspective, the explanatory power of this study is vested in my valid and persuasive explanations, as well as the context of the reader.

3.3 Data Generation Procedures

According to Creswell (2003), data generation procedures are basically the steps and methods used in generating and recording the data. For this study the data generation procedures included:

1. Indentifying the data;
2. Selecting the participants;
3. Method for data generation; and
4. Data Recording Technique.

3.3.1 Identifying the Data

Qualitative data were generated in this study. Qualitative data, according to Cohen et al. (2007), are usually generated from a smaller number of participants within a specific complex socio-cultural milieu or a case. However, although the number of participants is small, qualitative data tend to be detailed and rich with participants' descriptions, explanations and interpretations about the phenomenon investigated (Cohen et al., 2007, Creswell, 2003). The qualitative data for this study were basically the participants' voices, discourses and rationales about the purpose, design and implementation of practical assessment activities in the science SBA for the SISC.

3.3.2 Selecting the Participants

There were eight participants in this study. Seven of them were Form 4 (year 10) and 5 (year 11) science teachers, and one was a national curriculum development (CD) officer for secondary science. The seven teachers were from four senior secondary schools and the CD officer was from the Solomon Islands Curriculum Development Centre (CDC) head office. All of these institutions are located close to Honiara, the capital city of Solomon Islands, where most of the diverse communities and schools are situated. The eight participants reflected (but did not represent) the diversity and the complexity of the socio-cultural environments in the Solomon Islands science classrooms.

The criteria for identifying the seven science teachers were based on the teachers' involvement with Forms 4 and 5 science teaching, as well as their experience in conducting science SBA for the SISC. Similarly, the participant from the CDC office was selected on the basis that his office is directly involved in issues concerning the conception, design and implementation of science practical assessment activities in the SBA for secondary schools in Solomon Islands.

3.3.2.1 Schools

The four schools selected represented different categories of secondary schools in the Solomon Islands education system. Accordingly, two participants were senior science teachers in a national secondary school (NSS), administered by the

Solomon Islands Government under the Ministry of Education and Human Resources Development (MEHRD). Two other participants were science teachers in a provincial secondary school (PSS), administered by the Honiara City Council Education Authority. Two more participants were science teachers in a community high school (CHS) supported by a community under the administration of the South Seas Evangelistic Church Education Authority. The seventh participant was a senior science teacher in one of the national secondary schools administered by the Seventh-day Adventist Education Authority. Finally, one participant was a national secondary science curriculum development officer.

3.3.2.2 Background of Participants

A summary outlining the backgrounds of the participants is tabulated in Table 3.2 below. Pseudonyms selected by the researcher were used for the participants.

Table 3.2

Participant Background

Participant Pseudonym	School Type	Gender	Prior Education	Qualification	Teaching Experience	SBA Experience
Mata	CHS	F	UoC/ SICHE	BSc/ AdDipTSS	7 years	6 years
Wane	CHS	M	SICHE	DipTSS	3.5 years	4 months
Jen	PSS	F	SICHE	DipTSS	5 years	4 months
Pam	PSS	F	SICHE	DipTSS	4 months	4 months
Dan	NSS	M	USP, SICHE	BSc/ AdDipTSS	11 years	1 year
Sam	NSS	M	SICHE	DipTSS	5 years	3 years
Hans	NSS	M	Fulton, PAU	DipTSS, BEd	23 years	9 years
Liam	CDC	M	USP	BEd	10 years	5years

Note. The participant background includes their pseudonym; the type of school they taught in; gender; prior education; qualification; years of science teaching and experience in conducting the science SBA for the SISC.

The background of the participants indicates that there was a great range of differences and few similarities amongst some of the participants. Four out of the eight participants completed their pre-service teaching education at the Solomon Islands College of Higher Education (SICHE) with a Diploma in Teaching

Secondary Science (DipTSS). Two participants had previously attained Bachelor of Science (BSc) degrees; one from University of Canterbury (UoC), New Zealand and one from the University of the South Pacific (USP), Fiji. Then, both of them trained to be science teachers at the SICHE and completed Advanced Diploma in Teaching Secondary Science (AdDipTSS). One participant did his DipTSS in Fulton Adventist College in Fiji and Bachelor of Education (BEd) degree from the Pacific Adventist University (PAU) in Papua New Guinea and one other participant gained his BEd degree from the USP in Samoa then in Fiji.

The participants' experience of teaching secondary science also varied from 4 months to 23 years. Correspondingly, the participants' experience in conducting practical assessment activities in the SBA ranged from 4 months to 9 years.

3.3.2.3 Invitation to Participants

Following the ethics approval for this study from the Centre for Science and Technology Education Research (CSTER) ethics committee at the University of Waikato (UoW), in April 2009, I went to do five weeks field work in Honiara. Upon my arrival at the beginning of May 2009, I submitted my research application and letter *(see Appendix C)* seeking permission to do the study from the research committee of the Ministry of Education in Solomon Islands with a copy of the signed research proposal. Subsequently, letters informing and seeking permission to undertake the study with the participants were hand delivered to the principals of the four schools *(see Appendix D-D.1)* and the officer at the CDC head office *(see Appendix E-E.1)*. The letters were hand delivered since it was one of the more effective means to receive prompt responses in the Solomon Islands. However, it took me two weeks to get permission to involve the participants.

Teacher Participants

In the letters to the principals of the four schools, basic information *(see Appendix D-D.2)* on the nature of this research was outlined. In their letter, they were asked to invite one science teacher for Form 4 and one for Form 5 from their schools to participate in the research. Each principal was also given two sets of document including copies of a letter inviting the teacher participants, an information sheet outlining the research aims and significance, the nature of the participants'

involvement, and an informed consent form *(see Appendix F)*. Following their invitation, the potential teacher participants had to make voluntary decisions to participate in this study by signing the informed consent form given to them by their respective principals, as well as by myself prior to their participation.

Curriculum Officer Participant

The letter inviting the curriculum officer participant was hand delivered to him directly since it was within his jurisdiction to decide on his voluntary participation in the study. With the letter, an information sheet outlining the research aims and significance, the nature of his participation, and an informed consent form *(see Appendix E)* was included. However, his participation was on special consideration due to the sole nature of his position (refer to ethical considerations later).

3.3.3 Semi-Structured Interviews

The method of data generation used in this study was the semi-structured interview, which involved face-to-face verbal conversations. It is one of the three types of interviews used in interpretive and qualitative studies. The semi-structured interview is categorised according to its structure and schedule (Burns, 2000). It falls between unstructured interview, with open-ended questions at one end of a continuum and structured interview, with closed questions on the other. This method is used to elicit qualitative information and is intended to delve deeper into participants' beliefs, values and expressions or emotions concerning the phenomenon being investigated (DiCicco-Bloom & Crabtree, 2006). Burns (2000) suggested that semi-structured interview uses either part of open-ended or close-ended questions in an interview.

The semi-structured interview uses prepared open-ended questions to give the participants flexibility to express their views but at the same time gives the interview a sense of direction and control. This technique is a process whereby the researcher gradually builds rapport to gain trust and confidence with a participant in such a way that would keep the questioning during the interview "conversational" (Villasenor & Etkina, 2007, p. 106) and purposeful. In fact, it is a "social interpersonal encounter and not merely a data collection exercise"

(Cohen et al., 2007, p. 361). Hence, the prepared open-ended questions were not intended to elicit predetermined or expected responses but rather to explore the participants' perceptions with guidance on what direction the conversation should flow within the scope of the guided themes (Burns, 2000).

The semi-structured interview schedule is dependent on how the researcher makes decisions during the conversation, as a response to the participant's responses to the initial open-ended question. The prepared open-ended questions that follow are not necessarily asked in the same order with the same wordings for different participants (Burns, 1994). Rather, they are asked in an order that the researcher sees fit during the conversation to maintain focus on foregoing themes as guidelines. Basically, the researcher can subtly redirect conversations should participants responses are off track from the themes (Burns, 1994). The researcher can also ask new and probing questions during the interview to elicit more relevant information, depending on the participant's responses (Cohen et al., 2007). This subsequently gives the researcher the flexibility to reach the limits of the participants' knowledge and perceptions about the phenomenon investigated.

There are strengths and weaknesses in semi-structured interviews.

Table 3.3

Strengths and Weaknesses of semi-structured interviews

Strengths	Weaknesses
The relationship between researcher and participants is inter-subjective	Can be time consuming and expensive.
Good rapport can result in collecting in-depth data	Outcome of conversation depends on researchers' skills and ability.
Both participants' views and emotions can be expressed and captured.	Body languages unconsciously can interfere with participants' responses.
There is flexibility to clarify and simplify complex questions or issues using language natural to participants.	Participants can change their views after their reflections and there is no way of knowing whether it is a lie or not.
Confidential and sensitive issues can be managed.	Consistency can be difficult with different interviews
Conversations can be easily recorded on audio tapes or videos with participants' consent.	Conversations cannot be repeated with exact responses if reliability is valued.

Note. These strengths and weaknesses of semi-structured interviews are highlighted by Burns (1994) and Cohen et al. (2007).

With such strengths and weaknesses, it is the researcher as the interviewer who has to be reflexive in conducting such conversations. That is, the researcher has to "monitor their interactions...reactions, roles, biases and any other matters that might affect" (Cohen et al., 2007, p. 172) the conversation with the participants. As such, the semi-structured interviews were conducted as conversations in this study with a reflexive nature.

Basically, for this study, there were two semi-structured interview schedules. One for the CD officer participant *(see Appendix H)* and one for the teacher participants *(see Appendix G)*. Both interview schedules had the same number of questions with similar guiding themes. However, the first three open-ended questions were rephrased for the officer participant to suit the nature of his involvement in the phenomenon investigated but still focused on the guided themes.

3.3.3.1 Interviewing of Participants

All eight interviews were conducted within my last three weeks of field work in May 2009. At most I had three interviews per week and one per day. The time and place for the interview sessions were pre-arranged on an individual basis and the duration of most of the interviews ranged approximately from 30 to 60 minutes without disturbing the participants' official duties. Moreover, the interviews were conducted in pre-arranged places familiar to the participants. For example, for teacher participants the interviews were conducted in science laboratories and staff rooms, whilst the CD officer participant was interviewed in his office.

The interview schedules were printed and were given to the participants separately prior to their actual interview sessions. However, despite the fact that all questions were written in English, Pidgin was the main medium of communication during the interviews. Pidgin, sometimes known as 'broken English', is the national vernacular in Solomon Islands, though English is the official language. With Pidgin, the participants were more articulate and were able to express themselves better. Because of this, I had to simultaneously rephrase and translate the questions into Pidgin when asking them during the interview.

Initially for the interview, I started some kind of conversation as I walked with each participant to their respective interview locations. I just asked each of them about their school surroundings, programs, or gave comments on anything exciting that I saw in their schools. Those questions were asked of the participants as part of building the rapport with the participants. Then, preceding the eight questions, there were three closed questions that specifically focused on the participants' backgrounds. Thereafter, an introductory question was asked to set the momentum for the conversational questioning. That was followed by asking the eight questions in different order which was dependent on my decisions during the conversation as a result of the responses on an individual basis.

The interviews were flexible in a sense that, the participants were allowed to have the printed interview question sheet in front of them to refer to. Some participants wrote their ideas in short sentences on the printed sheets alongside each of the open-ended questions. Some of them repeated and rephrased the open-ended questions by themselves and re-collected their thoughts by re-reading the questions with their pre-written points. I assumed that helped them to focus their thoughts and responses when I asked a particular open-ended question. However, having the schedule in front of the participants seemed to make them anxious. Some continually asked about whether they had answered the questions correctly or whether they had missed some questions. Besides, I did not ask all of the prepared open-ended questions since, for most participants, their response to one particular open-ended question to some extent, also answered other questions that were not yet asked. That was to minimize repetition and boredom.

There were incidences in which I also provided probing questions and suggested terms to some of the participants who tried to express their views but found it difficult to use relevant English terms or the science education concepts which they could refer to. For example, one of the participants was illustrating some ideas concerning students doing science investigations but found it difficult to relate his ideas to the term 'investigation'. Instead he kept on using the term 'experiment'. Hence, at one point, I asked him by suggesting, "Did you mean students' investigations?" and he said, "Yes, yes". So, during the interview, I asked probing questions, as well as, provided illustrations and suggested terms and ideas in Pidgin to provide directions and to really elicit what the participants

were attempting to express. However, in doing so, I was also reflexive to the nature of each individual participant, not to intimidate and dictate the conversation.

3.3.4 Data Recording

An audiotape recorder was used to collect the qualitative data which were the actual spoken words of the participants (Patton, 2002). Supplementary field notes were also written after the interviews were audiotape recorded. The field notes provided the extensions to the logic and rationale behind the participants' interpretations (Borko et al., 2007).

3.3.4.1 Audiotape Recording

With most participants, the interviews were conducted in a position whereby we sat on separate single chairs adjacent to each other, at a table. For three of the participants, we sat facing each other but not in the direction where we were directly opposite. This was to minimise any discomfort the participants might have had due to the feeling of being examined or interrogated by another person (Cohen et al., 2007). I made the conversation social and more of sharing information whereby we conversed about what he or she perceived with respect to the phenomenon investigated. In addition, as part of ethical considerations, in the Solomon Islands culture, eye contact in conversations is regarded as disrespectful and it is not a common practice.

In most cases, the small external disc-shaped and highly sensitive microphone was placed on the table, about 40 centimetres in front, between the two of us. Its cord was plugged to a mini cassette recorder that was placed next to me for constant monitoring on my part. With the microphone in that position, it captured our voices more directly but at the same time it was not an obstacle that was in front to be constantly conscious of. However, in some instances with some of the participants, although the microphone was placed in that position, they sometimes, during the interview turned away from it. Especially, when they wanted to illustrate by fetching or pointing at something in the classroom, laboratories or staff room where the interviews took place. In some conversations, at some points during the audiotape recordings the loudness of the participants' voices faded way when they turned away and became louder when they faced the microphone again.

Two conversations were recorded, one on either side of a 90 minute audiotape and coded according to a selected code which identified and represented individual participants. Thereafter, I took all the audiotapes back to the Centre for Science and Technology Education Research (CSTER) at the University of Waikato, in New Zealand where my graduate office was located.

3.3.4.2 Field notes

In addition, documents relevant to the purpose of this research were also collected. For example, copies of the assessment items and my research diary. Field notes were written after the interviews, usually in the evenings. The field notes mainly contained my perceptions regarding my personal observations and reflections with regards to the behavioural qualities of the participants, and other relevant aspects that had explained and described the rationale behind the participants' perceptions.

3.4 Data Analysis Procedures

The significant facet in semi-structured interview is analysing the qualitative raw data generated and audio tape. Hence, I will outline the simple strategy that I used for analysing the qualitative data in this study. The strategy was used to analyse the qualitative data so that it retains its depth and richness "while still rendering the responses into a form which can be handled easily and reliably for analysis" (Atkins, 1984, p.254).

3.4.1 Transcribing

Firstly, the audiotapes were transcribed. Transcribing is often difficult since it is not easy to capture "the spoken word in text form because of sentence structure, use of quotations, omissions and mistaking words or phrases for others" (DiCicco-Bloom & Crabtree, 2006, p. 318). Despite that difficulty, I used a transcribing device at the STER Centre to transcribe the audiotape recordings into texts. Hence, all my transcribing was done at the University of Waikato in New Zealand. The device made it easier for me to listen to the participants' voices. As well, it helped me to listen to minute bits of phrase or a word over and over again.

However, since the conversations were in Pidgin, I actually translated the conversations myself before typing them in English quotes into a Microsoft word

document file for each participant. The quotes were typed under their respective questions in the order they were recorded in the conversation. Thereafter, I used the transcripts in the word documents to silently re-read them over again while listening to the Pidgin version of the recorded conversations several times to ensure the level of translation and accuracy.

Thereafter, I invited another Solomon Islander in Hamilton, New Zealand, who speaks and write both English and Pidgin fluently to repeatedly listen to the interview recordings and read through the transcripts simultaneously to verify the translations and the meanings independently. Subsequently, corrections were made and each typed transcript was coded using pseudonyms.

Then, the transcripts were airmailed to each participant, to whom the transcript belongs, for verification and the audiotape records were kept securely for further reference during the process of analysis.

3.4.2 Generating Themes from Data

The second step was to generate themes from the transcripts. Cohen et al. (2007) suggest that, qualitative data is heavily interpretive, thus analysing it is more reflexive and recursive than during the actual generation process. This also involved "making sense out of what the people have said,...and integrating what different people have said" (Patton, 2002, p. 380). With reflection, I evaluated the responses using my perceptions to organize the verified quotes in the transcripts into themes and subthemes.

At first, I grouped the quotes from the transcripts according to the question numbers since they had been prepared according to pre-guided themes. Hence, using the guiding themes, participants' quotes about their backgrounds were copied and pasted under their respective pseudonyms into a new word document with the file name, backgrounds. Likewise, quotes in response to the introductory question were filed in one separate new word document. Quotes for questions one and two were copied from individual transcripts and pasted into another new word document under the file name, 'aims of science teaching'. Beside each quote, the pseudonym to which the quote belongs was typed in brackets with bold letters. The same was done for all the questions under each guiding theme prepared.

Hence, one word document contained all the quotes related to a particular guiding theme prepared. For example, one word document contained all the quotes related to participants' backgrounds, another word document for quotes under introductory question, another one for quotes related to 'aims of science teaching', and so on so forth for all other themes prepared.

Then I printed the word document for each theme and read through it in order to identify emerging ideas. For example, the word documents for quotes in response to question one and two, 'aims of science teaching', were printed into a hard copy. Afterwards, I used a coloured pen to write alongside each participant's quote, the analysis ideas that emerged. This was done to all other word documents containing quotes in response to other questions under other guiding themes. Then I identified from all guiding themes, the similarities and differences amongst the ideas that emerged from the quotes. Subsequently, I used the computer again to copy the quotes from their respective word documents and paste them according to their similarities into a new word document which collated all the emerging subthemes. All quotes for similar ideas were grouped under their peculiar emerging subthemes. In fact, only the relevant parts of the quotes which spelled out the similarities or a single salient idea were copied and pasted under each pseudonym to which the quote belongs.

As a result, I formulated a long word document which contained all the emerging subthemes under the main prepared guiding themes. Under the subtheme titles, I placed all the relevant quotes that expressed or illustrated that particular idea and they were identified by the participants' pseudonyms.

The emerged subthemes were titled by noting the type of ideas in terms of "explanation or constructs" (Cohen et al., 2007, p.368). The subthemes that emerged from the quotes were named appropriately according to the explanations and the constructs from the participants. For example, one of the subthemes under implementation of practical assessment activities in the SBA was subtitled 'lack of equipment'.

The subthemes were constituents that made up the answers to the research questions. They were categorised according to how they integrated to answer one of the research questions. That involved going back to the word document which

contained all the subthemes under the prepared guiding themes and sorting them according to categories that intended to address the three research questions.

The final stage of data analysis was putting together of all the categories in order to develop a finding that addressed the purpose of the research (Cohen et al., 2007). In this stage, I basically reflected on the rationale and the purpose of this research. I synthesised all the guiding themes and emergent subthemes into a meaningful construct and findings that answered the three research questions. The whole construct is presented in the next chapter on findings (Chapter Four).

3.5 Ethical Concerns

Moral and ethical considerations were important in this study since the semi-structured interviews used were directly dealing with participants' lives and their right to privacy (DiCicco-Bloom & Crabtree, 2006). In fact, Bell and Cowie (1999) noted that:

> The ethical concerns were principally those of the ongoing maintenance of confidentiality with respect to the data; obtaining informed consent from all participants; monitoring for potential harm throughout the project; and the methods for dealing with any concerns of the (volunteer) participants with respect to being involved in a research project. (p. 199)

I will now outline the ethical considerations that I had maintained throughout this study.

3.5.1 Informed Consent

I provided each participant with an informed consent form and an information sheet right from the beginning. The two documents contained information outlining the aim of the study; the nature of their involvement and statements preserving their rights and privacy all through the study process. The statements included their rights to be kept informed about what was happening to the data they supplied; their rights to voice any complaints, withdraw their involvement from this study and/or withheld any information they had provided, at any time up to the time they confirmed and verified the data they generated. In addition, before

their informed consent was given, I personally went through the content of the informed consent form with each participant to ensure that each participant fully understand his or her rights in the research process. I also ensured that they consented to the use of pseudonyms in place of their real names.

3.5.2 Confidentiality

The confidentiality of the participants in this study was maximized but was not guaranteed because there were only eight participants and their school communities and the CDC head office are close knit inside the small city of Honiara. Its population is estimated at 59,100 people in 2007 (Solomon Islands National Statistic office, 2007). However, I continuously executed and monitored the recording, storing and analysing of the data generated with extreme care and respect. I used the data generated strictly for the purpose of this study and I also used pseudonyms for the participants such that their anonymity was maximized. In addition, a quasi-description of the four schools was given but their names were kept confidential and anonymous. With the curriculum officer participant, continuous strict consideration and consultation was executed and monitored because his anonymity was not easily addressed since he was the only officer in that position.

All raw data was stored in a locked cabinet in my office in the STER Centre at the University of Waikato in Hamilton, New Zealand until their purposes were served. Thereafter they were all kept securely and confidentially for a period of five years.

3.5.3 Potential Harm to Participants

I constantly monitored and assessed every situation by conversing with the participants regarding their comfortability in our interaction. I also notified them of their rights to express any social, physical, emotional, economic or cultural discomfort whatsoever that may hinder their participation. However, since I ensured their freedom of participation with the informed consents, less potential harm was anticipated.

3.5.4 Resolution of Disputes

There were no disputes during the generation and the analysis of the data. However, prior to their participation, I informed all participants that, should there be any dispute during the study process, I would initially carry out a consultative dialogue with them to resolve the dispute. If there was no subsequent resolution, my research supervisor would be notified for further clarification and explanation. Both my supervisor's and my contact addresses and phone numbers were printed on the information sheets that were given to each participant and to their superiors from the initial contact.

3.5.5 Other Ethical Concerns

Being a science teacher, researcher and a Solomon Islander I was vigilant to avoid conflicts of interest. Hence, I conducted the study respecting the cultural norms and the accepted practices within the local communities and I generated the data as a researcher and not a science teaching colleague. I did not coerce any participant by any means of favours or bribery by influencing any other interest groups to do so. I ensured that the participants were not made to feel that their privacy had been invaded or their time had been improperly used. Hence, I respected whatever the participants expressed or suggested with regards to their participation. For example, one participant said "I think that is all I can say". As a result, I concluded the conversation without going on further.

3.5.6 Ethical Statement

This study was undertaken within the University of Waikato Human Research Ethics Regulations 2008, Solomon Islands Research Act of 1982. In compliance with those the following issues were addressed. Informed consent of participants was obtained, without coercion. Exploitation (or perception of exploitation) of researcher-participant relationship was minimized. Privacy and confidentiality was respected. The participants owned the raw data generated, and their requests regarding the data were honoured (University of Waikato, 2008; Research Act, 1982).

3.6 Enhancement of Quality and Validity

The research was underpinned by the interpretive perspective and used the semi-structured interviews. The quality of this research was enhanced by maximizing validity and reliability through out its whole process. I will explain how the quality of this research was enhanced. Firstly, I will explain the notion of trustworthiness then I will discuss the construct and cultural validity of this study.

3.6.1 Trustworthiness

With interpretive (qualitative) studies "reliability and validity are conceptualized as trustworthiness, rigor and quality" (Golafshani, 2003, p. 604). Rigor involves the concept of subjectivity, reflexivity and social interactions while quality is associated with using terms appropriate to the interpretive perspective (Golafshani, 2003). Trustworthiness, according to Bell and Cowie (1996), is associated with the question of "whether something or someone may be trusted or relied upon to be true" (p. 11). This study was trustworthy because of the strategies outlined below.

- I was familiar with the phenomenon investigated since I was also a science teacher within the same context of this study. As such, I was in a better position to construct contextual and conceptual interpretations of the participants own and multiple constructs.
- I used triangulation of data sources (Cohen et al., 2007; Golafshani, 2003). This was based on the socio-cultural perspective which assumes that people's perceptions, beliefs and how they make sense of a situation is different from each other. Hence, selecting different participants from different schools which were influenced by different socio-cultural factors provided multiple constructions of views and experiences concerning the phenomenon investigated. Such rich and multiple constructions of views provide more credible data to be analyzed and can be transferable to similar, but diverse contexts.
- The transcripts were sent back to each participant, to whom it belongs, for verification. Although the participants suggested that it was not important for them to verify their transcripts, I airmailed the transcripts to them. Their

verification of transcripts was not expected as they had indicated this after their individual interviews. On the other hand, that was also an indication of trust between the participants and me as the researcher.

- An independent Solomon Islander in Hamilton, New Zealand, who speaks and write both English and Pidgin fluently, repeatedly listened to the interview recordings and read through the transcripts simultaneously to verify the translations and the meanings to the actual spoken words in the interviews. This enhanced dependability and conformability (Golafshani, 2003).

3.6.2 Validity

The concept of validity has many different aspects and different definitions and meanings which at times can be contentious, especially within interpretive paradigms (Cohen et al., 2007; Golafshani, 2003; Onwuegbuzie & Leech, 2007). From many kinds of validity I have decided to highlight two which enhanced the validity of this study: construct and cultural.

3.6.2.1 Construct Validity

According to Cohen et al. (2007), construct validity is addressed by legitimating the operations within a study according to the conceptual constructs which underpinned the operations. That is, whether the whole research design is constructed to represent what it theorised to represent. Underpinned by the interpretive perspective, the purpose of this study was legitimated in using semi-structured interviews. The open-ended questions in the semi-structured interviews were constructed to elicit the views and experiences of the participants about the phenomenon investigated. The open-ended questions were tested with other colleagues from the Solomon Islands who were familiar with the phenomenon investigated and were studying at the University of Waikato. The prepared open-ended questions were grouped under different guiding themes which were familiar to the participants (Cohen et al., 2007). The guiding themes also directed the interview conversations to elicit in-depth, rich and detailed explanations and interpretations about specific issues within the phenomenon investigated. The guiding themes were in line with issues pertinent to the phenomenon investigated as presented in other literature.

There was a threat of bias since I was familiar with the phenomenon investigated (Onwuegbuzie & Leech, 2007). However, I was reflexive and conscious not to dictate the conversations. In fact, I used my familiarity with the phenomenon investigated to guide my probing which brought out more in-depth, rich and contextual explanations and interpretations from the participants. Moreover, although my familiarity with the situation may be seen as a risk to seeing some key points, it was a bonus for me when I analysed and interpreted the meanings of the participants' constructs.

3.6.2.2 Cultural Validity

Cultural validity "involves a degree of sensitivity to the participants, cultures and circumstances being studied" (Cohen et al., 2007, p. 139). Bishop (1997) stressed some significant points about researchers being culturally sensitive so as to respect and understand meanings and interpretations in the context of the participants. He said it is crucial to research within "the cultural world view and discursive practice, within which the research participants function, make sense of their lives and understand their experiences" (p. 41). As a Solomon Islander and science teacher in the context of this study, I was not alien to the socio-cultural environment of the participants. Using the semi-structured interviews as conversations, my insider status was a bonus to the co-construction of meaning and interpretations in this study because we shared the similar socio-cultural understanding and experiences.

Summary of Research Design

In sum, this research design was underpinned by the interpretive paradigm and semi-structured interviews were used to generate qualitative data. The qualitative data was transcribed and analyzed rigorously to provide a sincere account with convincing explanations and interpretations of the participants' views about the phenomenon investigated. Ethical considerations were adhered to. Quality and validity was enhanced throughout the process of this study. Hence, the findings of this study are trustworthy and worth paying attention to (Lincoln & Guba, as cited in Golafshani, 2003). The findings are presented next in Chapter Four, followed by their discussion in Chapter Five and conclusion in Chapter Six.

CHAPTER FOUR: Research Findings

4.0 Chapter Overview

This chapter outlines and describes the findings of this study with the purpose of developing an understandable account of analysis from the views of the eight participants about the purpose, design and implementation of practical assessment activities in the School-Based Assessment (SBA) for the Solomon Islands School Certificate (SISC). This chapter is divided into the five sections.

- Section 4.1 – Views about the aim of teaching science and scientific methods.
- Section 4.2 – Views about the role and learning outcomes of science practical work.
- Section 4.3 – Views about what is assessed in the practical assessment activities in the school-based assessment.
- Section 4.4 –Views about the design and implementation of the science practical assessment activities in the school-based assessment.
- Section 4.5 – Participants' suggested changes to the science practical assessment activities in the school-based assessment.

As described in Chapter Three, the participants' views were elicited using semi-structured interviews. Their voices were audiotape recorded, transcribed and analysed recursively into emerging subthemes under eight guided themes constructed to answer the research questions.

1. What are the views of the participants with regards to the purpose, designs and implementation of science practical assessment activities in the SBA for SISC?
2. How do the participants view the science practical assessment activities in the SBA with regards to their beliefs and experiences in science teaching, learning and assessment?
3. What changes do the participants suggest for the design and implementation of science practical assessment activities for the SBA in Solomon Islands context?

The findings are presented with representative quotations extracted from the participants' transcripts. Notations such as 'XT, p. Y' are used following a direct quote, to indicate the participant from whom the quote was originated with the initial alphabet of the participant's pseudonym 'X' and the page number 'Y' of the transcript 'T' from which the quote was drawn.

4.1 Views about the Aim of Teaching Science and Scientific Methods

The participants were interviewed about what they viewed as the aims of teaching science and scientific methods as a baseline from which to interpret their views on the school-based assessment for the Solomon Islands School Certificate.

This section is divided into two subsections. The first subsection documents the participants' views and beliefs about the aims of teaching science. The second subsection describes the participant's understanding about scientific methods.

4.1.1 Aims of Teaching Science

The participants had several related, and some distinct beliefs about the aim of teaching science. The participants' views were grouped into the five main categories:

1. Acquisition of basic science concepts and skills;
2. Development of inquiry skills and understanding;
3. Awareness and being holistically informed;
4. Addressing a human need; and
5. Fulfillment of the science syllabus and preparation for national exams.

4.1.1.1 Acquisition of Basic Science Concepts and Skills

Four participants specifically commented that the aim of teaching science is for the students to learn the basic concepts and skills in science. In that respect, all four participants had the view that the aim to acquire basic science concepts and skills in schools would in turn benefit the students in their everyday lives.

Mata, a science teacher for seven years, expressed the view that the aim of teaching science is to teach science concepts and skills. In turn, the students can utilize such acquired skills and concepts in their everyday lives. She said:

> According to myself, I think that, I teach the concepts so that they can understand the concepts better then they can use the concepts everyday...They should be able to use the ideas that I thought them. They should be able to use the skills they have learnt. (MT, p. 2)

Mata also established that she sometimes related the science concepts to the students' everyday activities:

> ...mostly I do demonstrations, using everyday illustrations from the house, what they usually experience, or anything that they see along the road. I tried to relate science concepts to the children's everyday activity. (MT, p. 1)

Mata gave an example of what she viewed as some of the basic skills that students should learn in science classes. She said:

> I would like to teach the students not only for them to learn in class but, I would like them to use the ideas and skills out there. Some even do not know how to read scales and the balances. I want students to know how to read the balances so that, when they weigh fish at the market they will be able to read the scales. I think if student acquire such simple skills then I think that is successful. (MT, p. 2)

Likewise, Pam with just four months of teaching science in a secondary school, thought that the aim of teaching science is for the students to have an understanding of the basic concepts of science. She said:

> In my own thinking, the aim for teaching science is basically for the understanding of the basic concepts of science and for students to relate science to their daily lives. (PT, p. 1)

She continued:

> I expect students to learn how to apply the science concepts in real life situations. (PT, p. 1)

Similarly, Dan, a senior science teacher for eleven years, stated that the main aim of teaching science is to transmit knowledge and skills for students to understand the concepts and ideas of science, as well as for the students to acquire skills from practical work. He actually stated that:

> The main aim of teaching science is to transmit knowledge and skills for students to understand the concepts and ideas of science and also skills that they can acquire in and use in doing practical. Add on to that, the knowledge and skills that they acquire from science can also be used in other areas in their day to day lives. They can apply the knowledge and skills. (DT, p. 1)

And:

> ...students need to learn science concepts, skills and knowledge of science concepts. (DT, p. 1)

For Sam, a graduate teacher from Solomon Islands College of Higher Education (SICHE) who had been teaching science in secondary schools for five years said that, the aim of teaching science is to pass on the skills and the knowhow in science to the students in order to improve their lives. In turn they would improve their nation:

> Science as a subject is very important so that we pass on the skills and knowhow in science to the students whereby they will use them later on in their lives. To improve their lives as well as improve their nation. (ST, p. 1)

4.1.1.2 Development of Inquiry Skills and Understanding

Another conception the participants had with regards to the aim of teaching science is for the students to develop inquiry skills and understanding. Three of the participants said that when the students develop such inquiry skills and understanding in science they will be able to recognise science problems and issues in their civic lives and subsequently, they will be able to solve such science problems and issues.

Jen, a science teacher for five years, said that the aim of teaching science is to:

> Develop the students to have the inquiry skills, to help the students to solve problems, problems that will involve science methods. (JT, p. 1)

She continued to explain that:

> Students should develop the important skills in science, so that they can use the skills to solve the everyday problems that they will encounter. Because of the things today are based on science. So in order for them to solve the kind of problems now they have to know the ideas, knowledge and skills from science. (JT, p. 1)

Mata also shared the same view. In one of her responses she said:

> I teach the concepts so that they can understand the concepts better then they can use the concepts everyday to solve any problems that they come across. (MT, p. 2)

In addition, Mata said that she wanted her students to be able to analyse problems:

> I want the students to be able to analyze problems. When they come across a problem, they should know how to go about solving it, just thinking logically (MT, p. 2).

Similarly, Hans, a very experienced science teacher for more than twenty years, voiced a similar sentiment about the aim of teaching science. He emphasized his view by saying that:

> If they have a problem, why did the problem happen? what are the causes of the instances? and with their background knowledge they should be able to go about it. Say, they see something and just take it for granted, and eventually they just use myth or anything else because or it must be a custom or something like that. I mean I would be happy if students get to that stage where, after they have learnt something they have to put it back into practice. (HT, p. 1)

Basically, Hans was saying that the aim of teaching science is for the students to get to a stage whereby they will be able to make scientific decisions when they are faced with problems in their civic or professional lives.

4.1.1.3 Awareness and being holistically informed

Five of the eight participants specifically stated that the aim of teaching science is to inform the students about what is going on around them and to explain why and how certain phenomena happen the way they occurred. Such a view suggests that the aim of teaching science is for the students to be aware of and to be holistically informed about their environment and their world.

Wane, a science teacher for three and a half years in one of the secondary schools, said that the:

> Main aim for teaching science from my view as a teacher,...is to help students, for them to know what is going around them and teach them why certain things do happen; for them to have some knowledge on why certain things happen the way they happen. Mainly for them to have a knowledge about what is around them, things that happen to them, things that happen in everyday life, like that. How they can understand why things happen the way they do. (WT, p. 2)

In addition, Wane included his Christian beliefs that the awareness is also for the students to accept the concept that things existed and happened the way they happened because God had established those things and events in the first place. He stressed that the aim of teaching science to students is:

> ...not only for giving them the knowledge about things that happen around them but also for them to accept that, things that happen around them do not happen by themselves, but as result of what God has established in place. (WT, p. 2)

Jen also commented on the notion of awareness:

> ...main aim for teaching science, the basic is for awareness purposes for the students. (JT, p. 1)

Similarly, Hans expressed that the aim of teaching science is more holistic such that, students have the whole world of something to be aware of. He passionately expressed himself saying:

> I love the subject and then because when students come in they have a whole world of something to be aware of in front of them. (HT, p. 1)

Hans and Jen used the term 'awareness' to mean students having knowledge about the physical world and understanding how things exist and relate to each other and to their lives.

Hans further claimed that having awareness more holistically will be beneficial for the students in the long run. According to him, the benefits included both the material and the practical aspects of the knowledge and the skills in science. He stressed that:

> When they [students] come to grips with it, maybe in the long run, with what little knowledge they have and the practicality they can apply to it, which is what we are trying to do, all the material and practical aspect of it. (HT, p. 1)

In fact, Liam, the science curriculum development officer claimed that science as a subject is one of the holistic approaches in education to develop students holistically. He said that:

> ...science is one of the holistic approaches, at school we give holistic development to students and science is one of them. (LT, p. 1)

Hans and Liam used the term 'holistically' to mean that, students' knowledge and understanding in science can be applied in their everyday civic lives, not only in things related to science but all other aspects of their lives, such as making informed decisions.

For example, Liam explained:

> The student will become competitive, be able to make scientific decisions in the community or where they live...must be aware of scientific things so that he is able to make scientific decisions, decisions based on scientific knowledge. (LT, p. 2)

Related to the conception of students being aware and well informed holistically in science, Hans also pointed out two other aims in teaching science. He mentioned that, when students have such holistic awareness, in the long run, they may be able to devise or make own original things:

> All they come to learn about it is, maybe they will be able to devise or make their own original things where they can actually accomplish and use it, something like that. (HT, p. 1)

Supposedly, Hans' idea of holistic awareness was not only for the students to have the ability to make informed decisions in solving problems and addressing everyday issues but also for the students' to be reliable in making some things in their lives (which can be termed 'technology').

Likewise, with the aim for holistic awareness, Hans also noted that students should learn science to a level:

> ...where eventually all they learn in science as a subject should be able to be motivated in them. (HT, p. 2)

As well, Pam drew attention to the view that students need to develop honesty when learning science because science is all about relating honest information:

> I want students to be honest. That is because science is more about relating information or scientific findings. Hence, when I relate the information about what has been discovered I have to be honest and not to tell lies. So I expect the students to develop honest values and truthfulness and things like that. (PT, p. 1)

4.1.1.4 Addressing a Human Need

Addressing a human need was another aim of science teaching mentioned.

Liam said that, when teaching science:

> The main aim is to achieve a need, an issue, a problem; these are achieved if we go further and look at technology, that body of knowledge, using that body of knowledge then we apply. When we apply it, then you just get what you want or it solves the problem that you face. (LT, p.1)

Liam justified his view about science as a means to achieve a need by saying that science gives something to the students to address a human need. He further explained that, that is why science is also a core subject in secondary school education in the Solomon Islands. He said:

> Science is a core subject because it gives something to the students. Students benefit from it, if we see that humanity has its own needs and science can only give one need and it won't be every need. (LT, p. 1)

In clarifying his view about the aim of teaching science as a means to address a human need, Liam gave an illustration, saying:

> Like someone from a social study or geography may get a need as far as, we can write a story now, about genealogy. One has to identify when and where he comes from. So I term these as needs (LT, p. 1).

Liam said with knowledge and understanding in science:

> We make hydrogen bomb or we make nuclear bomb, the need of the nation's security. Or we need food, we adjust our food security. So with these issues or problems, we venture into the scientific world. We need to learn scientific skills. (LT, p. 2)

4.1.1.5 Fulfilment of the Science Syllabus and Preparation for National Exams

The belief that the aim of teaching science is to fulfil the national secondary science syllabus was shared by three participants with an array of views but having very similar implications.

Sam established that in teaching science, his main aim is to cover the national science syllabus and subsequently fulfil the national goals. He noted that:

> First thing, I must make sure that the syllabus that I cover must be covered and then what I want the student to know is that: to fulfil the national goals set out in the syllabus. (ST, p. 1)

Jen also mentioned that one of the aims of teaching science:

> ...is to prepare students for the standardized tests, like exams. For example, form 5s they will sit their exam maybe in September, so this is one aim for teaching science. (JT, p.1)

Hans when voicing that the aim of teaching science was for the students to reach a stage whereby they are motivated and are scientifically intuitive, also mentioned that:

> That is what I like in teaching science but because it goes in line with, I mean we have a syllabus to follow and do, within the formal setting of the classroom. (HT, p. 2)

4.1.2 Scientific Methods

The participants were asked for their views on what the scientific methods are because these are important background information with which to interpret their views about practical work and its assessment practices.

The participants' views about scientific methods and how scientists work were very similar. However, although the views were very much alike, it is more fitting to describe the views under the following two categories:

1. Similar to practical work; and
2. A systematic way.

4.1.2.1 Similar to Practical Work

Mata, Wane, Jen, Pam and Hans thought that scientific methods are characterized in practical work or a laboratory exercise which some of the participants referred to as experiments.

Mata had the view that scientific methods are similar to the experimental procedures that students use to follow when doing practical work in school laboratories. She explained that when faced with a situation, students should be curious and start to ask questions. She talked about how scientists use scientific methods:

> ...usually when I teach the form 1 kids, I tried to show them the ways in which we use to follow, like you see a situation or you are curious about a situation then …just like the normal lab reports where you have an aim. I see this situation, hence I want to find this aims, and then you do something about it. Like the experimental

> procedures we use to follow. Analyze their results and make a report about it. Then think about what else we can do. I think if students can follow such standard way of thinking it will help to work or imitate how scientists work. (MT, p. 3)

On the same note, Wane thought that school practical work is similar to scientific methods. In particular, he said:

> Scientific method, as I understand and know; I think practical work comes up with scientific method whereby, scientists or people who like to discover about things; they come up with questions, and then they try to find answers to the questions. So they come up with their own ideas or guesses and then they would come up with some experiments or some things that they will do to prove their ideas, which include planning and how they are going to do things or carry out the experiments. Then finally, they would come up with results and they would come with conclusion from what they found and then write down them for others to see. (WT, p. 2)

Similarly, although Jen was not really sure about how scientists work, she also had the thought that, school practical work is a bit like how scientists work. She said:

> How I understand, scientists have aims; hypothesis and then they try to do experiments to achieve what they think of. If they try to do the experiments and they come to that hypothesis, then they give it as one theory. I am not really sure about how scientists work. Basically, I think the practical is a bit like how scientists work. (JT, p. 2)

Pam, with a similar view, said that she never had the chance to talk to a real scientist. However, she thought that practical work in high school in a way, is trying to do what scientists actually do in real life:

> I do not have any chance in speaking to real scientist; however, in my own view I think they work just like what we are trying to do in the practical. They are trying to do observations, just to prove theories. So I think scientists must work in the similar way. (PT, p. 2)

Hans also acknowledged that practical work is one of the examples of scientific methods although scientists may be working with advanced technologies. He stressed that:

> At this level, maybe we don't get down to the condition where scientists work, maybe we do not reach it, but at least the apparatus, the most common ones, scientists maybe using advance technologies, at least they [students] would know how to do samples. (HT, p. 3)

4.1.2.2 A Systematic Way

Dan, Sam and Liam viewed scientific methods as a systematic way of creating new knowledge and theories in science.

Seemingly, apart from the view that scientific methods are similar to the practical work conducted in schools, Dan thought that scientific methods are a systematic way of acquiring ideas and theories. He explained:

> Okay my understanding about scientific method is; it is one systematic way where scientists acquire different ideas and theories in science, this systematic way where they follow, I think it is to acquire different theories and new ideas in science. And I think there are some steps to be followed at least certain steps where they follow, such that at the end of going through the steps, they can get a new theory or new idea in science. That is what I think. (DT, p. 2)

Sam indicated that he viewed scientific methods as a systematic work whereby there are set guidelines and procedures to follow. As such, according to Sam, unnecessary errors can be avoided. He said:

> Well...scientific method is a systematic work. So when designing practical we have to follow procedure so that we may avoid unnecessary errors or such kind. However, there are times where we need improvements on the procedures. (ST, p. 2)

Liam stressed that scientists work in a systematic way:

> Scientist works in a systematic way, he observes things, he has inferences, he has predictions; he has hypothesis, orderly and progressively, progressiveness. Scientific work is mainly on reality, mostly. And in fact he is man who goes beyond the planet, he goes further. He is a man who finds reality, someone with some thoughts of knowledge, and he did trial and error. Based on certain experiences or own experiences he make some assumptions and he want to prove them and hence in proving, he makes new discoveries. (LT, p. 2)

Summary

The participants were interviewed about their understandings on the aims of science teaching and scientific methods to act as background data for the assessment of science practical work questions. In sum, all the eight the participants were able to talk about these things. This indicated that, although their science teaching experiences varied from 4 months to 23 years, all of them had views and could elaborate the aims of science teaching and scientific methods.

My feeling is that the participants' views about the main aim of science teaching and scientific methods were much the same way as other science teachers in other countries. For example; Ekiz's (2004) study on 15 primary school teachers in Turkey, and Wahyudi's (2007) study on 32 teacher educators in Kenya.

4.2 Views about the Role of Practical Work and Learning Outcomes in Practical Work

The participants' views about the roles and the learning outcomes in practical work were elicited in order to provide explanations for their views on how to assess students' practical work.

The first subsection in the section outlines the views of the role of practical work whilst the second subsection describes the participants' views of the learning outcomes in practical work.

4.2.1 Role of Practical Work

The participants had the beliefs that practical work in science education helped students to develop:

1. Knowledge and understanding of concepts in science;
2. Scientific skills;
3. Scientific attitudes; and
4. Procedural understanding.

4.2.1.1 Develop Knowledge and Understanding of Science Concepts

All eight participants held the view that practical work can better help students to understand the theories and the concepts they learn in science.

Mata said:

> I think practical work can aid understanding for students about the theories that they learn. (MT, p. 2)

To further clarify, she said:

> For example, if I just write the equation for speed when I teach the concept of speed, they will not get what I want to find. So I have to

> ask them for us to go outside and do a bit of running. When we do that then they would say, oh now I know that distance is what a run. I also use the clock for timing, that's when they experience what you tried to teach them. (MT, p. 2)

Similarly, Sam said that practical work is one very important aspect of science, especially in the teaching and learning of science:

> It is one very important aspect of science; teaching and learning science because through doing practical, it will help students to know what we are trying to put across to students (ST, p. 1).

Sam continued:

> I think, so far, students feel that that they know more about the concepts when we do practical work. And when we do not do practical works, we make science as something abstract where we are not part of it. So it is easier to do practical so we need practical (ST, p. 1).

Having the same view, but using the term 'experiment' instead of 'practical work', Jen expressed a similar sentiment, saying:

> Okay, the experiments help students to understand better the theories and the basic concepts in science. Hence, once the students do them, these will help students understand the theories and concepts better. (JT, p. 1)

Hans also responded in the same vein as Sam and Jen:

> ...what they learn theoretically, they can see in practical. Something that we talk about, this is how it goes. They can actually see, which makes it more concrete to the concept because the concept is there, concrete affirmation is more than, it's the practical, and they should be able to really say that, ok now I can see... it will sort of improve the affirmative and the definitive...the idea is, if we can use the practical experiments to explain the theoretical part of that. We talk about the concept and then come down to do the practical. Then you are making that concept much clearer. They actually use all the senses. They hear, they see, they feel, they touch, they smell, they taste if not dangerous. Even if they don't taste it, at least they know. (HT, p. 3)

He also said:

> I want them at least to be able to see that, as something that really brings the concept much more concrete way of thinking. Because if it is just only the concept, some of them will not be able to grasp them, and nothing concrete, like you see the effect. For some, the concept is just a floating something like that. They would say yes, yes, yes but because it is all in a different sort of realm to them, they cannot really touch it, using our five senses to able to say oh this is... (HT, p. 2)

Pam emphasized that practical work should be done after lecturing or after teaching the science concepts. She said:

> ...it is good that teachers give practical work after lectures or teaching science concepts. They [students] can question more and develop their understanding to another higher level of thinking. (PT, p. 1)

Likewise, Liam stressed that students can only do something, in this case practical work, if they have prior knowledge:

> Yes, so practical work to me; you can only do something if you have a prior knowledge. (LT, p. 2)

Wane also expressed the view that students are carrying out practical work or hands-on activities to see and to think about the knowledge they learn in theories. He said practical work is:

> ...actually for the students to touch things, see things handle things like that and think about what happen and also for carrying out, what they learn in knowledge, they actually see happen in practice. (WT, p. 2)

Similarly Dan commented that:

> ...students will come to appreciate the component of practical work which helps to strengthen their knowledge on different concepts and ideas of science. (DT, p. 1)

This view was further affirmed by Pam when she clarified that practical work helps students to understand science concepts better. She recalled the saying:

> I think this trans-proverb is very good; where it says, what you hear, you forget; what you see, you remember; what you do, you understand. (PT, p. 1)

4.2.1.2 Develop Scientific Skills

In addition to the view that practical work helps students to understand science concepts better, Mata also viewed practical work as an activity whereby students develop and acquire scientific skills:

> Another thing is, you want to pass on the skills to them. The simple skills that I have talked about will be useful to them in their everyday lives. (MT, p. 2)

In the same way, Pam said that practical work makes science teaching more effective in the sense that students actually see and have hands-on experience which in turn, helps the students to learn the science concepts and acquire more scientific skills:

> Science is more effective if the students have the opportunity to see and have hands-on experience on practical work. The students will not only learn the concepts more but also to acquire more skills. (PT, p. 1)

Similarly, Wane also viewed that practical work is for:

> ... Helping students to know how to use things like instruments or even doing set ups in experiments. (WT, p. 2)

Moreover, Hans made a remark that students need the practical skills in science because in referring to some feedback from the University of the South Pacific (USP), he said:

> ...in fact, there is feedback from USP, where a lot of our students go in, if they lack the practical aspect of it, I think they will not know actually what to do, like they would not know the proper names, or how to use them. All of these things, if they just know the procedures, they are not used to handling it. (HT, p. 2)

In other words, Hans was saying that practical skills are important for students especially when they go on to pursue further studies in science.

Dan also mentioned that students should:

> ...develop skills that they can use to do the practical exercises. That is one main thing that practical work does in the classroom. (DT, p. 1)

Likewise, Sam stressed that skills are important in practical work:

> In fact skills are important because in science, when we deal with specific equipments, students must be able to handle them. (ST, p. 1)

Liam concurred that practical work is about doing something or manipulating equipment in science. He also stressed the importance of developing skills in practical work, saying:

> I think practical work is something that is practical, its something with doing, it is hands-on. At the merit of touching, you feel it, you are actually moving your body, moving your hands, at the same time having the sense of constructive instructions there, where it instruct you to take a beaker, use this certain amount of liquid, use this chemical. So actually it is hands-on, doing it now. (LT, p. 1)

4.2.1.3 Develop Scientific Attitudes

One of the participants, Dan, commented that doing practical work helped students to develop scientific attitudes:

> Okay practical work, in my thinking it is the skills and the attitudes; also for attitudes. (DT, p. 1)

The other seven participants did not mention views about developing students' attitudes as one of the roles of practical work.

4.2.1.4 Develop Procedural Understanding

One participant had the view that practical work is a simulation of the processes that students need to learn in order to be able to solve problems in real life situations. Mata was the only participant who stressed the importance of students developing the understanding of the processes involved in solving a problem when doing practical work. She claimed that:

> ...when you solve any problem in the class, it is more like; you are simulating what will be happening out there in real life. So the students may use the processes that you've gone through with them in class to solve the problems outside. (MT, p. 2)

In other words, Mata was referring to the concept of students acquiring the procedural knowledge and understanding in order to solve problems. As such, she had the view that one role of practical work is to simulate such procedural knowledge or knowledge of how to proceed.

4.2.2 Learning Outcomes in Practical Work

The participants' views about the learning outcomes in practical work were elicited because these views are significant in interpreting their views about what to assess in practical work.

The following were the participants' views about the learning outcomes of practical work in science education. They thought that students should be able to:

1. Correctly identify, name and use equipments in science;
2. Demonstrate their skills of investigation;
3. Demonstrate their understanding in science; and

4. Show appreciation of science concepts.

4.2.2.1 Correctly Identify, Name and Use Equipment in Science

The following participants had the view that one of the main learning outcomes in practical work is for the students to correctly identify, name and use the equipment in science.

Dan said that students:

> ...should be able to use appropriately the different apparatus in the science lab. Correct use of the apparatus. That will include correct measurements, using apparatus to make correct measurements when they do practical exercises. I think these are the main outcomes. (DT, p. 2)

Mata gave an example:

> ...the learning outcomes should be what I taught in class, so if I teach them how to read a balance then they should be able to read it correctly, in a right way. (MT, p. 2)

Likewise, Hans also talked about some aspects of the skills that students should acquire in practical work with reference to feedback from the University of the South Pacific where most Solomon Islands students do tertiary studies. He stressed that part of the skills acquired in practical work included identifying and knowing the correct names of scientific equipment as well as how to use them correctly. He said:

> ...they [students] know the names of all the apparatus and they are competent to handle them, otherwise they are just clumsy...It is better to do it on that level, so that even during lecture, if we say 'Go and get a burette', What is a burette? 'You bring a pipette', What is a pipette? And all this single things, if they don't know, then at the first place we are putting them on the wrong footing. So if they have one of these things and they know how to confidently handle it, I see it in the long run, to do research work if there is something in this area, then they should be able to perform competently. (HT, p. 3)

4.2.2.2 Demonstrating Skills of Investigation.

Four of the participants viewed that the learning outcome in practical work should be demonstrated in the students' ability to follow instructions, make observations, make proper measurements and analyse and write conclusions in line with the expected aims.

Wane commented that when students do practical work, they should be able to:

> ...follow the instructions confidentially and also for them to know how to observe. For students to be able to observe what happens and also to write conclusions about why those things happen...For measuring, observe, draw conclusion and for following instructions, describing things and things like that. (WT, p. 2)

In the same way, Jen also mentioned that:

> ...students should be able to follow instructions and they should have the skills to analyze and interpret information. (JT, p. 2)

Liam went on further to emphasize the importance of students demonstrating their skills not only in following instructions and observing but to the extent whereby the desired aim for a practical work is reached:

> You have a certain aim, you want to reach an outcome, you want a result, and you want to observe something. You will observe it there; whether it's a popping sound instantly or something that you will observe within a month because it will grow. (LT, p. 1)

Mata also had a view about students demonstrating their skills in presenting their reports in a correct way:

> ...should also present their reports in a correct way, whether in written or verbal form. (MT, p. 2)

Moreover, she commented that when students learn and understand the concepts and processes in science they should be able to demonstrate their understanding when solving problems. She illustrated her point by describing the way she does things:

> Like, when I do things this way, it is very biased, hence I will do the other way so that the results can be altered. Finding alternative ways of solving problems should be discovered during practical work. I want to see students to do the whole process of identifying problems, planning, investigating to finding answers. (MT, p. 2)

In fact, Mata was stressing the notion of students being able to recognise a problem or an issue; make decisions on how to go about addressing the problem or issue; plan an investigation and find explanations.

4.2.2.3 Demonstrating Understandings in Science

Two participants held the view that the learning outcome of practical work is for the students to be able to demonstrate their understanding in science.

Mata had the view that in doing practical work, students should be able to demonstrate their understanding in science concepts and procedures. That is, according to Mata, the students should be able to articulate or explain what they understand in science to other people in a way that other people would easily understand too. She said students should:

> ...talk about it in a way that people will be able to understand them. These are some of the things that I want to be the learning outcomes. (MT, p. 2)

A similar view was also expressed by Liam when he described the idea of students being skilled people having the ability to apply their science understanding in their communities, societies and nations. He said:

> In fact, the learning outcome in science practical work... is on the part of the student. The student is able to apply much, he became a skilled person. Being observant and all those things...Now importantly, like anybody or community in the world, there are problems in the scientific society and nation or community, so the outcome; we'll see the achievement level inside the student. (LT, p. 2)

4.2.2.4 Show Appreciation of Science Concepts

Three of the participants also had the view that, one of the learning outcomes in practical work is for the students to have an appreciation of science concepts that are related to their daily lives. That is, students should value the use of science concepts in their everyday lives.

Pam, in one of her responses, said that she expected her students to appreciate science concepts that are related to their daily lives. She said:

> What I expect the students to achieve; the students will appreciate science concepts that are more related to their daily lives. (PT, p. 2)

Similarly, Mata also pointed out that:

> If I teach the students concepts they should appreciate it, and said yes, I understand it. (MT, p. 2)

Hans, in one of his responses, also expressed the view of students appreciating the science concepts, especially when they can better understand the concepts because of their experience in practical work. When referring to doing practical work as a means to make science concepts tangible, Hans stressed that:

> ...students too will appreciate and understand the concepts deeper. (HT, p. 1)

These three participants specifically used the term 'appreciate' to mean how students should value the knowledge they acquired about science concepts.

Summary

The participants' views about the role and the learning outcomes of practical work were important to interpret their views about the assessment of practical work. All eight participants had the view that the role of practical work is to develop students' understanding of the science concepts. Seven of them had the view that it is also for the development of manual skills in doing science. Only one participant said that the role of practical work is for students' procedural understanding and one other participant said it is to develop students' attitudes in science. With that, three of the eight participants mentioned they wanted their students to demonstrate their skills in making correct measurements, naming and handling of science equipment. Two said they wanted their students to demonstrate their understanding of science concepts. Three of the participants also mentioned that they wanted their students to show appreciation of the science concepts by valuing them. These were expressed as ideals and the following section (4.3) report on what they felt was actually assessed by the current school-based assessment tasks.

4.3 Views about the Assessment of Practical Work in School-Based Assessment (SBA) for the Solomon Islands School Certificate (SISC)

This section documents the participants' views about what is assessed in the SBA practical work.

4.3.1 What is assessed in SBA Practical Work

From the participants' responses, there were five categories of what they thought is assessed in the SBA of practical work for the SISC.

1. Assessment of students' understanding of science concepts.
2. Assessment of students' skills in practical work.
3. Assessment of the learning outcomes stated in the SBA handbook.
4. Inadequate assessments.
5. Summative assessments.

4.3.1.1 Assessment of Students' Understanding of Science Concepts

Four of the eight participants commented that, the assessments of practical work in the SBA for the SISC are assessing the students' understanding of science concepts.

Mata said the assessments of practical work in the SBA are mainly assessing the students' understanding of the concepts rather than their skills. In referring to the assessment of practical work as experiments she said:

> Okay for the experiments, like I have said earlier, for the understanding of concepts maybe yes, because after they do the experiments then they answer the questions. But for the skills I do not really know. (MT, p. 4)

Sam noted that the assessments in the SBA practical work are assessing what the students have learnt in the SISC science syllabus:

> Well, beside the practical, so far I see, in fact in the practical assessments, we are covering the topics where the students have learnt in the syllabus. Again, that is in line with the syllabus. (ST, p. 2)

Hans also said that, the SBA practical assessment activities are derived from the SISC science content. As such, he claimed the assessments in the practical work are basically assessing the concepts the students have learnt in the SISC science course content. He clarified this, saying:

> ...whoever set the SBA; they basically pull it out from the contents of the course work. So what I see, the experiments also support, so it works very closely, it is not something where, we learn this but we take something totally outside...What I note is that because they have

> talked about it in the course content then they put them in the activities. As I have said earlier on, what they probably don't see in the concept they would see it practical work. (HT, p. 5)

Hans explained that:

> When you talk about environmental issues, there is a SBA on environment, when you talk about eco-system. So same with eco-system, marine and maybe other interests within science, like pollution, maybe rubbish disposal. (HT, p. 5)

Jen also commented that one main thing in assessing practical work is to assess the students' understanding of the concepts investigated:

> One main thing is to assess students understanding about the concepts in practical work. (JT, p. 2)

Four of the eight participants shared the view that assessments of the SBA practical work is assessing students' understanding of the concepts they have learnt in the science syllabus. The other four participants did not particularly mention this view when answering the semi-structured open-ended question, they mentioned other views.

4.3.1.2 Assessment of Students' Skills in Practical Work

Two of the eight participants shared the view that the SBA was assessing students' skills in science.

Jen, in one of her responses, said:

> I think basically the assessments in the practical are assessing the skills that are required for students to learn. (JT, p. 2)

She exemplified her statement by saying that the assessments are assessing these skills:

> Like for following instruction, for handling apparatus and materials the way scientists would have done it. How to interpret data, results and observations they see during the experiments. (JT, p. 2)

Similarly, Liam stressed that the assessments of the practical work in the SBA assess students' skills in science rather than their understanding of the science concepts. When asked about his view about the assessment of practical work in the SBA, Liam responded by saying:

> ...I think that is an important question. Assessing the skills is more than assessing the concepts because concept is something that they already find and that can be assessed in the written exam. Now assessing the skills is very important. We want the students to have the scientific skills. (LT, p. 3)

Liam, the curriculum development officer, emphasised the importance of assessing the students' skills in practical work rather than their understanding of science concepts. He clarified that the students' understanding of concepts can be assessed in the written exams whereas the assessment of their skills is done in the assessment of practical work. He outlined an example from the Solomon Islands science SBA handbook:

> Let's take one example from the SBA handbook. So we have an assessment schedule here. Like it talks about assessing the students' ability to follow instruction, the abilities to collect, to record, calculate, analyse and to use equipments, handling, touching whatever, drawing graphs, reasoning, stating sort of a conclusion. We have here an example of assessment where skills are assessed rather than assessing the knowledge. You have 10 marks here. (LT, p. 3)

Liam continued to explain why he perceived the assessment of practical work in the SBA is to assess students' science skills rather than assessing their understanding of the science concepts. He said, the students:

> ...would use a bit of knowledge from reading the instructions there. As they go from step to step, they would find out the body of knowledge but we are not assessing them on that body of knowledge, we more or less assess them, as you can see, on the aspect of how they handle, doing things in the laboratory. Then the results will come out of that body of knowledge. When the students know how to handle the practical the concepts will fall in naturally, automatically. If they don't know how to handle or collect gas which they know already, they have the opportunity there already, like they will write it down. (LT, p. 3)

In his explanation, Liam highlighted that although students need the science knowledge and understanding to enable them to carry out the steps in practical work, it is the skills that are assessed. Liam claimed in his explanation that, when students successfully carry out their practical work by performing the right skills, the knowledge of the phenomenon investigated will be constructed by the students as well. In other words, according to Liam, the skills that students develop in practical work are significant whereby they can actually perform to see the evidence that in turn would affirm their prior conceptual understandings. He pointed out that if students do not have the skills to perform practical work they

would not be able to see or witness the concepts behind the phenomena. He illustrated this in referring to students' skills when he stressed that:

> ...if they are not able to read 1kg of mass; if they are not able to know how to use adhesive tape then the knowledge that they learn in class cannot be seen or become tangible. So we assess the skills. (LT, p. 3)

Apart from these two participants the other six participants did not elaborate on this view. Their responses were varied with different views which are presented under other subthemes.

4.3.1.3 Assessment of the Learning Outcomes in the SBA Handbook

One participant had the view that the assessments in the SBA practical work are assessing the learning outcomes of practical work as listed in the SISC science SBA handbook. The learning outcomes listed in the SBA handbook are documented in Appendix A- section 2.0 and 7.0.

Wane commented:

> I think the SBA covers some parts of the experiments which students need to know. Yea, I would say that it is good; it achieves some of the objectives in the school-based assessment. (WT, p. 2)

For example, he said:

> ...for them [students] to write the aims, able to write the methods, results which they themselves come up with it, their own findings which are one of the learning outcomes; Also to draw up own conclusion from experiments; And to use the instruments and be able to observe and write them down. These are outcomes from doing practical and I see that the practical assessment assesses these outcomes in practical work. (WT, p. 2)

4.3.1.4 Inadequate Assessment

Four of the eight participants shared the view that the assessments in the SBA practical work are inadequate in terms of assessing students' skills, as well as students' understanding of science concepts.

Dan thought that the assessments in the SBA practical work assess only a small portion of the science concepts the students have learnt:

> ...in my own thinking, there is nothing. Because some of these activities, for one, the assessments are very much concentrated on

> only one or two topics in the SBA and most of the topics are not covered. So if you look at assessment of science, I would think it is very small. It does not assess the other different topics and concepts covered in Forms 4 and 5. (DT, p. 2)

Similarly, in referring to the students, Jen said:

> ...the existing nine practical work means that they only do nine concepts in the practical. So other concepts that students learn in class are not in the practical works. (JT, p. 2)

In other words, Jen expressed that only nine concepts are assessed in the practical work since there are only nine practical assessment activities in the science SBA. As such, according to Jen, the assessments in the SBA of practical work are insufficient in terms of assessing the concepts in the SISC science content. It needs to be noted that the SBA of practical work is not specifically intended to assess conceptual understanding, although content knowledge would be used in the practical work (*see report sheets - Appendix B*).

Moreover, with a slightly different view concerning students' skills and experience but still having a similar connotation of inadequate assessment, Jen also said:

> I don't think they will learn any thing if it is their first time, but if they have experienced the practical work from Form 1 right up to Form 5, they would learn some things from the practical assessments. (JT, p. 2)

Jen had the view that students would not be capable of performing the practical assessment activities if they did not have the prior science knowledge and skills. Hence, assessing the students in practical work was inadequate because the students would not be able to perform the practical work. For example, she said:

> ...some just experience and observe what a test tube looks like when they are in Form 5. That is the first time they handle equipment. So I think students will only learn a bit from the practical assessments. (JT, p. 2)

Pam also made a claim that the assessments did not adequately assess what the students had learnt. She elaborated:

> I do not think that assessment really assesses what the students learnt. Maybe some students are good at certain topics so when they do practical work, some will do better and others not. I think it is a bit unfair in some sense. (PT, p. 2)

Pam and Jen shared the view that the assessments of the SBA practical work are inadequate in a sense that some or most students are incapable of performing the assessed practical activities, as they had not learnt them and did not have the skills.

In referring to the assessment of skills, Mata claimed that:

> ...The assessment of skills is not done, so much is not done. I don't know whether the students learn anything or just for the sake of completing the assessment paper and hand it in at the end of the assessment activities. (MT, p. 5)

We can infer that Mata was saying the practical assessment activities in the SBA did not assess students' skills for summative purposes, and that they were not used for weak formative purposes. In addition, she also commented on the marking criteria for students' research project:

> I don't think the marking criteria are really good because I am not sure about how students go about the whole research. (MT, p. 4)

4.3.1.5 Summative Assessment

Two participants noted that the SBA was summative assessment and therefore there was no need to give feedback to students after the practical assessment activities.

According to Sam:

> The assessment marks are part of SISC, therefore I do not think that the students should get feedback, these are confidential information so students do not need to know them. Besides, the students will not do them next time because all the practical works, they just do them once. (ST, p. 3)

Similarly, Liam said:

> Currently, it is the practice that we don't give feedback. I think the least we can do now is the moderation. (LT, p. 4)

He further said that:

> ...giving feedback to students is important since it helps for improvement whilst it is still there; However if you give feedback after exam, whether the student has passed or not. There is no guarantee for feedback; the student is already prepared to move to the next level. (LT, p. 4)

Liam illustrated that:

> In any circumstance, whether in an athletic field or on a snooker table, you will assess the achievement of someone and of course no one wants a poor or low performance. You can only know whether a student knows science well or not, when you assess. When you still not assess you do not know what level the student is at, and of course we don't want lower level, we want high level, high quality. So yes, we want to know assessing practical work or we want to know whether something is good or not or something is of low quality or high quality. (LT, p. 3)

In other words, according to Liam and Sam, the practical assessments in the SBA are purposely for summative assessments.

Summary

Four of the eight participants saw the science SBA as assessing the science concepts the students have learnt in their SISC science syllabus even though this is not an intended learning outcome to be assessed by the SBA. Two of the eight participants mentioned that the SBA is assessing the students' skills in handling the apparatus and following the procedures. Four participants saw the SBA as inadequate in assessing the students' skills and understanding of concepts both for summative and weak formative purposes. However, two out of the eight participants had the view that the SBA is specifically for summative purposes while only one participant saw that SBA is specifically assessing the learning outcomes in the SBA Handbook.

4.4 Views about the Design and the Implementation of Practical Assessment Activities in the SBA for SISC

There are two major subsections in this section. The first subsection presents the participants' views about the design and the schedule of the SBA practical assessment activities in SISC. The second subsection presents the participants' views about the implementation of the SBA practical assessment activities in SISC.

4.4.1 Views about the Design and Schedule

The participants' views about the current design and the schedule of the SBA practical assessment activities are categorized under the following:

1. Reasonable;
2. Lack of flexibility;
3. Lack of pre-testing;
4. Unfair weightings; and
5. Appropriateness.

4.4.1.1 Reasonable

Six of the participants had the general view that the design of the practical assessment activities in the SBA for the SISC was fair and reasonable.

Mata, being an experienced teacher, thought that the research project is good in the sense that such practical activity allows students to individually identify problems and find ways to address the problems. She said:

> Concerning the research projects, I think they are good. The research projects allow the students to identify problems and find ways to solve or find answers to the problems. (MT, p. 4)

She continued:

> I think the assessment schedule is fair because it spreads over a year. Once I complete a unit that one experiment come under, I can allow the students to do it, hence that is all right. So I think it is okay to spread the practical assessments. (MT, p. 4)

Wane had the view that the practical assessment activities achieved some of the objectives in the SBA:

> I think the SBA covers some parts of the experiments which students need to know. Yea, I would say that it is good, it achieves some the objectives in the school-based assessment. (WT, p. 2)

He went on to comment that:

> The schedules are good, everything is good. (WT, p. 3)

He specifically mentioned that:

> The method that students fill in the blank spaces in practical work sheet is really good. It is already set and only need for students to write down the methods, aim, results, and conclusions. (WT, p. 3)

Dan also thought that the combination of practical work and research project in the science SBA is all right, especially when the practical assessment activities covered the three disciplines of Physics, Chemistry and Biology in science education. As such, in referring to the practical work, Dan said:

> I think it is all right, I mean: because there are three practicals for each of the strand; that is Physics, Chemistry and Biology. One is teacher designed and two are common. Looking at the amount of work they are okay. (DT, p. 2)

Dan went on to say that the science SBA schedule for practical work is reasonable since it is spread over a two year period:

> ...for practical I think the schedule is okay since it spreads out through out the two year period (DT, p. 2).

Similarly, Liam made this comment with regards to the amount of practical assessment activities in the SBA:

> We have total of nine practical, but the three sciences have equal number of practical, that is three practical each plus one research. The practical assessment we design must come out from the body of knowledge that is in the syllabus so, when I see it I think it is okay because the students are given the opportunity to learn the skills. (LT, p. 3)

In addition Sam said:

> ...The designs, chemicals and the apparatus used are good. (ST, p. 2)

More specifically, Mata commended that having three Teacher Designed Assessment Practicals (TDAP) in the SBA is good because teachers can design practical assessment activities according to the availability of equipment in their schools. She said:

> ...the three teacher designed ones are nice, because we usually designed them according to what we have available. Such as, these apparatus we have, such chemicals we have etc., and use something we have available. I think this is good. (MT, p. 3)

On the same line of thinking, Hans claimed that the science curriculum panel introduced the Teacher Designed Assessment Practical (TDAP) to address the constraints in schools due to the lack of facilities and equipment:

> ...If I look back, the science curriculum, the science panel is trying to address it by saying; okay you will have TDAP. (HT, p. 4)

Hence, he noted that the TDAP is a means whereby teachers can flexibly conduct practical assessment activities according to the syllabus and their schools:

> Now TDAP, teacher designed task, should cater for one or two things that you cannot do according to the experiment or the syllabus because you don't have the facilities, apparatus, equipment or chemicals. (HT, p. 3)

4.4.1.2 Lack of Flexibility

Although Mata held the view that the TDAP is reasonable and addresses the short fall in the lack of equipment in schools, she still thought that the TDAP lacks flexibility. Mata argued with reference to the TDAP by saying:

> ...I think this is good. But then, the SBA office still wants us to design our teacher designed activities like the ones in the SBA handbook. They do not allow us to let the students to do experiments by themselves and ask them to design it. (MT, p. 3)

In other words, although TDAP is reasonable, there was lack of flexibility whereby teachers can facilitate student designed investigations.

Mata was critical that the Common Assessment Practical (CAP) and even the TDAP are very much directed because the procedures are clearly outlined in the SBA handbook and there is already a template designed for results:

> For example, for the predesigned ones, they follow the experimental procedures but they only write the aim, whereas, the whole write up is already designed. The template is there, they only need to complete it by writing down the answers. There is no room for students to think of other ways of presenting it. It is much directed. (MT, p. 3)

She went on to say:

> ...I do not think the students really get the way or how scientist should work. The way which you yourself identify the problems and then you find ways to solve them. It is like the whole experimental procedure is already been outlined for them. (MT, p. 3)

In addition, Mata also made a similar critique about the research project in the SBA. Although she said that the research project is good since students are given the opportunity to work individually in identifying and writing about a problem, she claimed that, on the other hand:

> ...most students these days always look for information that are already there, similar to the experimental designs they usually do. Hence, sometimes most students just copy literature facts and ideas instead of discovering for themselves. (MT, p. 3)

While the language used by Mata may indicate her use of a discovery view of learning, she can be seen to be referring to the students having to think for themselves about the design of an investigation. This may be obvious to her given her long experience in teaching science and conducting SBA in the SISC:

> My observation for the past how many years that I taught science, students hardly do things to prove an equation or experimenting. Most of them just go and do literature review, about 99 percent. They just get the information that is already existed. (MT, p. 4)

Sam also commented:

> ...so far the work that students did for the last three years, I see that most of the work or more than 50 percent of the work were not produced by the students. So that is one problem with the research work (ST, p. 2).

In other words, according to Sam, students were not doing much investigation in the research project. He saw the research project as being an information location activity, not a practical one.

4.4.1.3 Lack of Pre-testing

Dan, being a USP graduate in chemistry, expressed his concern with regards to the pretesting of the CAP in the SBA. He said,

> One concern with the common assessment practical is that many of the practical haven't been tested before doing the practical. So sometimes, you'll find that the practical do not work for the very reason where whoever prepare the practical have not tested it. (DT, p. 3)

He further illustrated his point by saying:

> One example is the rate of reaction. Whoever design this experiment, the amount of acid is too dilute that the reaction should happen within the time period of doing the experiment but instead the reaction go

> ahead over the time. So the reaction should complete within the time period, so people who prepare the practical may not do prior testing. (DT, p. 3)

4.4.1.4 Unfair Weightings

Dan and Sam also shared the view that the weighting for the research project and the time spent on the project is not balanced. Dan stressed that, for the research:

> ...a lot of students spend a lot of time in doing the research over two year period, however, its weighting is just five percent. (DT, p. 2)

Similarly, Sam attested that:

> ...research work will take about one year for the students to complete; however, they give very small percentage, which is five percent towards it. I see that, that is not fair. (ST, p. 3)

He subsequently justified his claim by saying:

> How would you do one year work and you are just given five percent, but comparing to the practical work, they just do it within one hour and it worth even 10 percent or something like that. (ST, p. 3)

Both Dan and Sam saw the mark allocation for the research project and the practical assessment activities as being not fair in terms of the amount of time students spent on doing the respective activities compared to their allocated assessment weightings. Both of them said it took the students one year to complete the research project but it is only worth five percent while the practical assessment activities were conducted within one hour periods but their weightings were 10 percent for each practical activity.

4.4.1.5 Appropriateness

With another frame of reference, when asked about the design and the schedule of the current SBA practical assessment activities, Liam responded by saying:

> ...the current SBA whether it is good or bad, I think it depends on circumstances with time. Time changes, so I think the current one is the best one for this age, for this time. (LT, p. 2)

He further justified his perception that the design and schedule of the current SBA is based on the current national science syllabus:

> ...the syllabus is an endorsed document for the Ministry of Education. So I think, we can say whether the design is good or bad depends on when the time comes. (LT, p. 2)

4.4.2 Implementation of SBA Practical Assessment Activities

There were five main categories of responses about the implementation of the practical assessment activities in the science SBA for the SISC. The five categories are:

1. Lack of science equipment in secondary schools;
2. Number of students in a science class;
3. Timing and likelihood for cheating;
4. Teachers' ability to carry out the assessments; and
5. Safety in doing practical assessment activities.

4.4.2.1 Lack of Science Equipment in Secondary Schools

Seven of the eight participants commented on the lack of even basic science equipment in schools. Although valuing the aims of teaching science and conducting science practical work, the participants commented on the constraints in the availability of science equipment that were affecting the way they carried out the practical assessment activities.

Walking through with her into their school laboratory, Mata pointed out the lack of equipment for teaching practical skills in science:

> Okay over here, as you can see, we do not have a proper lab which I can use to perform the kind of things that I would like to do in order for the children's understanding to go deeper... for some concepts, which I think the students need to do its related experiment for better understanding, I will try and look at the resources that we have. If equipments are available then I will let the students to go ahead with the experiments. (MT, p. 3)

She continued:

> ... Some chemicals that are required in the designed experiments are no longer available with us. So sometimes we struggle to do the experiments or else we just do different experiments altogether. Sometimes we are penalized by the SBA office for doing such things, because it is not in the SBA handbook. (MT, p. 3)

We can infer that one of the main constraints that Mata had with the implementation of the practical assessment activities is the lack of science equipment. Likewise, this view was also expressed by Wane who was teaching in the same school as Mata. Wane said:

> If everything is there then it would be really good. When things are not available, that is when things are not good. In my own teaching, when I look for things that are required in the practical and they are not there, that is not really good. (WT, p. 3)

Similarly, Pam who taught in a city council school (Provincial Secondary School, [PSS]), unlike Mata and Wane who taught in a Community High School (CHS), also commented on the lack of equipment in many schools:

> I do not think many schools can carry out the activities since most schools do not have the facilities to do so...not all schools are well equipped to carry out the practical activities [in the SBA]. (PT, p. 2)

Jen who taught in the same school as Pam also said:

> I am sure some schools will not have the facilities and the equipments to conduct experiments. So that, experiment though it is an assessment, some schools will not do it because they don't have the equipment. (JT, p. 2)

Dan, a teacher in one of the National Secondary Schools (NSS) in Solomon Islands, commented on the equipment required in the practical assessment activities:

> ...a lot of equipment we use for practical work is not plenty or available in most of our schools in the Solomon's especially, our outer islands, provinces. They don't have access to some of the equipments. (DT, p. 3)

Dan was referring to the lack of equipment in most schools that can also be used for the practical assessment activities in the SBA.

Hans, a teacher in one of the church schools located in Honiara, stressed that, many schools are located in different places around the country. As such, he described his view on some of the difficulties that different schools encounter due to the lack science equipment. He explained:

> ...at schools we have different locations and it depends. Schools around Honiara, fewer problems, when you are short of one chemical, you can run over there and find it, you have access to it. (HT, p. 4)

Hans expressed the importance of having the right equipment to do practical assessment activities, especially in the SBA. He subsequently stressed the idea of uniformity whereby the practical assessments are done with similar apparatus in all schools such that the results are the same and the assessments are fair in all the schools. He said:

> You talk about senior community high schools out in the provinces, when you do not measure things properly, and if you use some natural things around, maybe if it is not properly done, the result you get will be far from what the people who actually do it rightly with the right chemicals and even apparatus. Oh, you just go to some of the schools and look at their science lab and look at some of their equipment. (HT, p. 4)

Han's reference to the lack of science equipment in many schools was to highlight the issue of lack of uniformity in implementing the science practical assessment activities and the need for all the students to be assessed uniformly using the same measures. Hans gave an example which illustrated his view on the need for using the same or identical equipment for practical assessments activities, especially for the common assessment practical (CAP). He said:

> ...for some instead of using beaker they only use cans. No proper measuring cylinder. What are they going to do, to measure liquid? So they just a get cup that has measurement on it, all of these will give wide variety of results. So are we going to mark this like this or...? Whereas if they do the same thing, the only thing is that, they don't have the correct answers. (HT, p. 4)

In his illustration, Hans highlighted the fact that many schools do not have the proper science equipment for the CAP. Hence, they would resort to other available apparatus which might not give uniform measurements and intended answers. For this reason he alleged that assessing or marking the students' practical assessment activities will not be uniform across the country.

Moreover, being the science curriculum development officer, Liam went to another level of whether schools have proper laboratories or not. He said that one of the problems in implementing the science practical assessment activities in the SBA is:

> ...The availability of science equipment that includes, whether the school has a science laboratory or not. (LT, p. 4)

4.4.2.2 Number of Students

Three participants voiced their views that the number of students in a science class to do the practical assessments activities is quite large.

For example, Sam mentioned that the number of students in one science class influenced the way teachers perform or conduct the practical assessment activities in the SBA. He said:

> ...The number of students in the classes now is too much, therefore practical works are difficult to perform. (ST, p. 2)

Similarly, Mata argued that assessment of students' manual skills in the practical assessments activities was not possible due to the limited availability of science equipment. She admitted that:

> ...for the skills I do not really know because everyone just go and handle the apparatus, like six or seven students to one apparatus. Hence sometimes you are lost, which student do I assess? That is one problem with us. (MT, p. 4)

Mata went on to say:

> ...but the research is okay, because each individual do their own work, so I can assess them. I can assess what they do according to my marking criteria. (MT, p. 4)

She was alluding to the reality that the research project is an individual student activity whereas, although the practical assessment activities were intended for individual student performance, it was quite difficult to assess individual students due to the large number of students because of limited availability of science equipment.

A similar difficulty was mentioned by Hans. In stressing the lack of science equipment for practical activities, Hans gave an example of how the number of students affected the way students conduct their practical work. Moreover, he also pointed out the lack of skill development for students in the teaching of practical work due to the large number of students per practical activity. For example, he said:

> ...there is not enough equipment per student to adequately say...okay you go and do this experiment, one on one. Most schools in the Solomon, our setting now is at a minimal number of equipment

> available in schools to share among six to eight students and some schools is not that. So what happens is, you know, when it is time for experiment, like practical, one is doing hands-on and the rest just take information. Or weighing, one sees it, reading, one sees it and then he tells the others, so the rest, are used to sitting down and just record. (HT, pp. 2-3)

It is assumed that Hans' difficulty in the teaching of practical work due to too many students per piece of equipment, also affected the implementation of the practical assessment activities in the SBA.

4.4.2.3 Timing and Cheating

Two views were raised by five of the eight participants when considering the implementation of the science SBA practical assessment activities in the SISC. One view was about the timing of when to do the practical assessment activities in schools and the other was about the high likelihood of students cheating and teachers fixing assessment marks for students.

Sam said:

> One thing that I see as a problem is the timing to do the practical works. Because we cannot be sure or NESU [National Examination and Standards Unit] cannot be sure that every teacher will follow their schedule, because it is quite hard to monitor. So that is one problem. (ST, p. 2)

He continued with an example:

> ...in our case, all schools in the Solomon Islands do not do the practical uniformly. They do not do it at the same time, because if they do it at the same time, they will avoid the kind of students copying or cheating. (ST, p. 2)

Sam was voicing a concern that since different schools conducted their practical assessment activities at different times and not the same time, there was likelihood that students in one school will cheat from students in a another school. Subsequently, he said, the NESU (National Examination and Selection Unit) in the Solomon Islands Ministry of Education is not able to monitor such cases.

Similarly, Mata expressed the view that students easily cheat from each other in the same class due to the fact that students work in groups because of the lack of resources. She said:

> ...from my experience, when I usually mark the pre-design practical and all of us sit down together because of lack of resources in a lab, the students can just copy or cheat from each other. (MT, p. 5)

In referring to the students' research project she also said:

> They just submit the final report. Sometimes when you read through, you are not sure whether the student really did the research or somebody else did it for the student (MT, p. 4).

Pam also voiced a concern that teachers may cheat, especially with schools that do not have the equipment to do the practical assessment activities. Pam was concerned that teachers may fix or allocate arbitrary assessment marks for their students instead of students actually doing the practical assessment activities:

> Maybe some school just can not carry out practical so tendency for teachers to cheat is high. They can just make up by giving marks to their students. (PT, p. 2)

Likewise, Jen also said that:

> ...some schools will hardly do these practical works. So teachers will just allocate guess marks to students for the sake of assessment because no equipment. And we can not borrow too. (JT, p. 3)

In addition, Hans pointed out that most of the practical assessment activities are repeated. He said:

> ...some of the experiments are being repeated, whoever is doing just pull out some from the past. I have seen some practical in there that were done in 2003, 2005 and 2006. I conducted some of the practical works and I note them back in 2007 and 2008. (HT, p. 5)

We can infer here that Hans' view about doing the practical assessment activities repeatedly over the years may tempt the students and the teachers in the later years to cheat from the work sheets that belong to those who already did them in the past.

4.4.2.4 Teachers' Ability to Carry Out the Practical Assessment Activities

Liam, the curriculum development officer, noted that one of the problems in implementing the science SBA is that of the science teacher qualification, experience and professionalism. He said that one of his concerns with the implementation of practical assessment activities in the SBA for SISC:

> ...Is the teachers' qualifications and their experiences. (LT, p. 3)

He continued to clarify his claim by saying:

> ...It comes back to whether this teacher graduate or not, his or her experiences. We talk about the teachers being informed, well informed about SBA and are able to follow instructions. (LT, p. 4)

Teacher professionalism is also an important aspect of implementing the SBA practical assessment activities. Liam explained:

> To me, professional person maybe a different person from the actual knowledge he or she have. It is an attitudinal thing. It comes back to personality, whether a teacher is a good teacher or is not a good teacher and vice versa. (LT, p. 4)

He exemplified some of the attitudes that teachers should adhere to, in being professional teachers:

> So its professionalism in terms of a keeping things in secret or what do we say, confidential. Like, sometimes some teachers at the moment use last year's work and then they do not take away things and burn them. So students like Form 4 this year will use them again. (LT, p. 4)

In other words, Liam had the view that, professional teachers should maximize confidentiality and they should avoid using previous years work or replicating of practical assessment activities every year. Moreover, Liam's view was more about the teachers' ability to effectively implement the SBA practical assessment activities. He stressed that:

> Whether a teacher design a practical or not, it comes back to qualification, experience, professionalism and then teacher resources. Resources which can aid teachers to do practical, but if no resources then the teacher will be one step down from other colleagues in other schools. (LT, p. 4)

Besides, he pointed out that some teachers were quite late in submitting their TDAPs and schedules to the science curriculum development office for approval. Accordingly, he said:

> Teachers send their design practical and schedule to my office, but the problem is that, the envelopes are here, I just receive them. Some teachers just hand in their design practical and their schedules of the whole booklet. (LT, p. 4)

Liam was referring to the SBA requirement where science teachers should submit three Teacher Design Assessment Practicals (TDAP) schedules and students' research topics to the Curriculum Development Centre (CDC) office for approval at the beginning when a group of student first enrol in Form 4 (year 10). The three TDAP with other six Common Assessment Practicals (CAP) and students' research projects are done over two years. At the end of the two years when the same students complete their Form 5 (year 11), all their assessment percentages are added up for their SBA grades.

4.4.2.5 Safety

Three participants commented on the safety in implementing the practical assessment activities in each school.

Safety in the school laboratory was also a concern for Liam:

> ...The safety in the laboratory is a concern for me. (LT, p. 4)

Similarly, Wane stated that one of his concerns in implementing the practical assessment activities in the SISC science SBA is safety. He said that:

> ...safety too is a concern because we are working with some dangerous chemicals too. (WT, p. 3)

Accordingly to Pam, safety is important:

> ...For chemistry it will be quite difficult because chemicals need a lot of care indoor. (PT, p. 2)

We can infer that the three participants were concerned about the safety of carrying out practical work in schools which we may also apply to the practical assessment activities in the SBA.

Summary

Six out of the eight participants saw the design and the schedule of the SBA as reasonable while two out of eight thought that the SBA lacked flexibility. One of the participants thought there was lack of pretesting of practical assessment activities and two saw that the assessment weightings were not fair. One of the eight participants viewed the design and the schedule for the SBA as appropriate for a certain time period.

With regards to the implementation, seven out of the eight participants saw the lack of science equipment as a great concern. Three out of the eight participants also thought that the number of students per science class was a problem in the implementation of practical assessment. Three of the participants also had a concern with the safety aspect of the practical assessments. Five out of the eight participants viewed the timing for doing the practical assessment as a problem causing the students to cheat and mark fixing by teachers. Lastly, one of the participants saw teachers' ability to carry out the SBA practical assessment activities as a concern in the implementation.

4.5 Views about Suggested Changes to the Science SBA for the SISC

The participants' suggested changes to the design and the implementation of the practical assessment activities in the SBA for the SISC are grouped into the following four main categories:

1. Wider consultation;
2. Adjustment to assessment techniques and purposes;
3. Adjustment to weightings and timings; and
4. Other suggested changes.

4.5. 1 Wider Consultation

The participants' views concerning wider consultation included the following, the SBA officers to visit secondary schools; to include students' views; and allow teachers to participate more in the design and implementation of practical assessment activities in the SBA for the SISC.

4.5.1.1 SBA Officers to Visit Secondary Schools

Three of the participants commented that SBA officers should visit the secondary schools which have Forms 4 and 5 (year 10 and 11).

Jen said:

> I just think that the people who design the practical should take a tour to all the schools that have Forms 4 and 5. They should check that the

> schools have labs, and equipment, and then they should come back, sit down and talk about what kind of assessment in the topics for Forms 4 and 5. They could design practical assessments which involve the materials that are available in every school, including rural schools. So that it is fair for everyone. (JT, p. 3)

Similar to Jen, Pam commented:

> I am not sure whether these people who design the practical actually go around the schools to observe the science labs. (PT, p. 3)

Dan also had noted that:

> It would be better if whoever prepares the experiments, equipments and other things to be used should be things that we can find in our schools and we can find access to. (DT, p. 3)

4.5.1.2 Students' Views

Sam stressed that it is important to have students' views about the practical assessment activities:

> I think, it is important to take students' views regarding practical assessments because then, the curriculum officers will get the students concerns. I think not to change the system but to take the students views. (ST, p. 3)

4.5.1.3 More Teacher Participation

Three of the eight participants commented that teachers should participate more in the design and the implementation of the SBA for the SISC.

Liam said:

> Maybe another one which is important is that teachers must give their views, this one we are talking about the quality. (LT, p. 4)

It is assumed that Liam was talking about teachers' views about the designing of the TDAP in the SBA. In addition, Mata also commented:

> The SBA should be quite flexible in allowing teachers to design experiments according to their available resources. Then we ourselves can assess them according to all the skills, so that we can assess their understanding of the concepts, and also the skills that they use to achieve that. (MT, p. 5)

Similarly, Pam said:

> SBA should allow majority of the practicals to be designed by the teachers. (PT, p. 3)

It can be inferred that Pam suggested the number of Teacher Design Assessment Practicals (TDAP) should be increased. Her comment was in reference to the current SBA which consists of three TDAPs, six Common Assessment Practical (CAP) and one research project.

4.5.2 Adjustment to Assessment Techniques and Purpose

The participants also voiced six suggestions about adjusting the assessment techniques and purposes in the SBA for the SISC.

1. Inclusion of investigative skills for assessment.
2. Assessment of the actual handling skills in the practical activities.
3. More formative assessment.
4. Assessment should be innovative.
5. Assessment at different stages in a practical activity.

4.5.2.1 Inclusion of Investigative Skills for Assessment

Three of the eight participants held a view that the SBA design and schedules should include more assessment of investigative skills.

Mata commented that students should be assessed on their investigative skills:

> I want to see the skills starting from seeing a problem and then formulating aims on how to solve the problem. Then we ourselves can assess them according to all the skills, so that we can assess their understanding of the concepts, and also the skills that they use to achieve that. The main point here is for students to involve more in investigative studies where most of their skills can be demonstrated and assessed. (MT, p. 4)

Dan also said:

> We just give them topic and ask the students; How will you get this, or arrive at this? Just give the students the aim, and then the students themselves would plan, carry out the process in doing the experiment. So this has different outcomes that are determined by how we prepare the practical. (DT, p.3)

Similarly Hans commented:

> We should be able to accommodate, where you come up with problem and then they [students] sit down and try to look at using what they have learnt to say, 'oh! I have learnt this, this is the problem, how if we go like this'...Coming up with problem solving is much better. Here is a problem, you are faced with a problem and then you have to find a solution. So a problem-based situation or solution is more eminent to find, I would say that that is something which is even more proactive in that level. So that you don't just do the conventional one where the students almost just close their eyes and do them. (HT, p. 6)

Hans here explained that practical assessment activities should encourage students to demonstrate their investigative skills.

4.5.2.2 Assessment of Actual Handling Skills

Dan mentioned:

> If we try to look at the students handling skills, then for practical assessment, that is when they actually do the experiment. Hence, we assess them when they do the experiment, assess them on the spot. (DT, p. 3)

According to Dan, assessment of the students' handling skills should be done when students actually handle the science equipment and not on evidence from written reports.

4.5.2.3 Formative Assessment

Dan and Hans suggested that giving feedback to students after they performed each practical assessment activity should be encouraged. That is, each summative assessment could be used for weak formative assessment.

Dan stressed:

> It is good to give feedback to students after marking the practical so that students know where, I mean where they stand, what are their weakness and strengths, so that in any future practical they would improve on their weakness. It is good that the marked practical be given back for the purpose of the students themselves can identify their weaknesses when looking through them. Anything that they don't understand and they made mistake on, they could ask and you can clarify and point out the weak areas. So for that purpose, it is good for us to give back on the marked work rather than just keeping them for making assessment only. (DT, p. 4)

Similarly Hans recalled:

> Feedback time is very important. I think this one is going back to the teachers. A lot of our teachers have fallen short on this, feedback time. Over here, every beginning of the year we are reminded by our own teachers doing in-service for ourselves. I have attended a workshop by the SPBEA [South Pacific Bureau for Educational Assessment]; they said that feedback time is very important. You have to mark quickly and give them back because you still talking about the topic. It is not good after you have marked but you've already moved on a different thing. Students cannot easily recognize where they go wrong. I think all the teachers should do this. This is not a new thing; teachers have been drummed to give feedback. (HT, p. 6)

It is assumed Hans was referring to feedback in science teaching and learning but it be can inferred here that he was also referring to the importance of feedback in the practical assessment activities.

4.5.2.4 Assessment Innovations

Hans expressed his view that assessment innovations are needed for the design of the practical assessment activities in the school-based assessment. Although, the science school-based assessment for the Solomon Islands School Certificate is reviewed after every two years (*see Appendix A*). Hans said:

> You don't use the same stuff back again... Maybe looking at it in a different angle, next time we'll see it this way, so that it will not cause us to do the same things. (HT, p. 6)

It is assumed Hans suggested that the practical assessment activities should be changed regularly having different approaches or designs but still having the same learning outcomes in the science SBA for the Solomon Islands School Certificate.

4.5.2.5 Assessment of Multiple Aspects to Students Learning and Development

Dan mentioned that school-based assessment can be used to assess other aspects of science learnt from the Solomon Islands School Certificate science syllabus. He said:

> I think the assessment of SBA now in the practical is more or less the same thing. Like, correct measurement, follow instructions, correct conclusion, use of apparatus. If we could look at other areas to do assessment, after all we want the students to acquire knowledge, skills and attitudes towards science. So students should understand more of the concepts and at the same time they should have the skills, and attitude; they appreciate the certain usage of practical in science courses. (DT, p. 3)

On the same note, Wane suggested:

> Just some additions to the assessment of students in science; not only for the students to do the practical but also for them to present their practical verbally...When they explain verbally they can explain better and also this can help them remember better. That is... one thing I want it to be added, let us say one assessment is also for the verbal presentation. (WT, p. 3)

4.5.2.6 Assessment in Stages

One participant suggested that the research project could be assessed as each section was completed, presumably to use the summative assessment for formative purposes also. Regarding the research project in the SBA, Mata suggested:

> Like, if they come back at different stages, then I would assess them at different stages. Such as when they collect information, then when they start to formulate aims for doing research... I can assess what they do according to my marking criteria. (MT, p. 4)

4.5.3 Adjustment to Weightings and Timings

The participants suggested the following adjustment to the weightings and the timings for the SBA practical assessment activities:

1. Weighting must be proportional to the time spent on the activity;
2. Re-introduce a one-shot practical exam.

4.5.3.1 Fair Weightings

Fair weightings for each component of the SBA of practical work was mentioned by four out of the eight participants.

Pam said:

> I think the practical activities on topics that require more time to cover should take more marks than others. (PT, p. 2)

In addition, Dan commented on the research project:

> I think the weightings for the research should be increased, because looking at the amount of work and effort spend on it is much bigger than the practical whereby students just do the experiment and do the write up and hand in at the same time. So if you look at the time spent on the research, its weighting should be increased. (DT, p. 2)

On the same note, Mata said:

> There are more skills involved in doing research. They should allocate more marks for research. (MT, p. 4)

Referring to the overall SISC science assessment, Liam suggested:

> I think there should be equal weighting. If we want to utilise practical work we must encourage it, in weighting, level it with the written exam. And then we draw up the activities that really ensure that students are learning science. We need to raise the level of the practical so that its weighting is equal to the weighting of the three hour written exam, 50-50. (LT, p. 4)

Similar to Liam, Hans commented:

> SBA as far as I know now is catered for about 15 percent unless they move it up. At least 15 percent of the total, major weighting is still on the exams but I think if it can be increased a bit further because one thing that you will note. Not all students come here to take examinable subjects. Some will just black out when you give them exams. Today I see 15 percent is a bit low, they should give internal assessment more weights. (HT, p. 5)

4.5.3.2 Re-introduce One Shot Practical Exam

One participant suggested that students' science practical skills should be assessed in a one-shot practical examination.

Sam suggested:

> Well, one best way I can see is that, we go back to the old way of doing practical assessments. That is, all the students in Solomon Islands do it on the same day like what had been done in the past. That is, doing practical sessions first and later on they do the exam. (ST, p. 3)

Sam here was referring to the assessment technique used in the past science final examinations for Solomon Islands School Certificate where there was one written external examination and one common practical examination at the completion of Form 5 (year 11) (*see section 1.4.5*).

4.5.4 Other Suggested Changes

The participants also suggested the following changes:

1. Increase the number of practical assessment activities in the SBA;

2. SBA office to provide the materials for the common assessment practicals (CAP);
3. Secondary schools should have science classrooms and laboratories.
4. SBA should be introduced in the lower forms or junior secondary level (year 7 to year 9); and
5. Regular teacher professional development.

4.5.4.1 Increase Practical Assessment Activities

As a suggested change to improve the assessment of practical work, Jen suggested:

> I think they should put more practical in the SBA. (JT, p. 2)

Likewise, Dan said:

> It is good, if we could increase the number of practical for each of the topics for Form 4 and 5, so that they can cater for the topics. (DT, p. 3)

4.5.4.2 SBA office to provide the Materials for the CAP

Hans suggested that the SBA office should supply the materials needed for the common assessment practical (CAP):

> If you do a project or SBA assessment in practical wise experiment, it will be better to reach everyone, then you say, ok this one will be common, we [SBA office] will supply you this...So it is good if it is a common assessment as what they want to do by calling it common assessment, everyone has to do, then the chemicals, the equipments everything must be provided so that they [students] work with the same things. (HT, p. 4)

4.5.4.3 Need Science Classrooms and Laboratories

Liam also recommended that new science classrooms and laboratories would improve the SBA of practical skills:

> Well, we need classrooms; we need laboratory to prepare for practical work because there are six to eight subjects and time limitation. (LT, p. 5)

4.5.4.4 Introduce SBA in Lower Forms

To improve the SBA of practical skills, Wane suggested:

> I think SBA should come down to lower forms under Forms 4 and 5. (WT, p. 2)

It is assumed that Wane suggested that SBA should be introduced in the lower or junior secondary school level, because he said:

> ...SBA covers some parts of the experiments which students need to know. (WT, p. 2)

It can be inferred that Wane perceived that the skills developed and assessed in practical work should also be taught and learnt in the junior secondary level.

4.5.4.5 Teacher Professional Development

Jen was the only participant who recommended that teachers should do training on how to carry out the school-based assessment for the Solomon Islands School Certificate:

> I think teachers need to involve in training to carry out practical like that, because in doing practical teachers also need skills so that the teacher can demonstrate those skills to the students. The students may get the skills from observing the teachers. (JT, p. 3)

The teachers' role in designing the Teacher Designed Assessment Practical (TDAP) and implementing the school-based assessment is very important (*see Appendix A-section 5.2*) because they are using their pedagogical content knowledge. That is, the knowledge of what, why and how to teach the content, process and skills in science. This was discussed in section 2.2.3.4.

Summary of Findings

This chapter indicated that the participants' views about the aims of science teaching, the role and learning outcomes of practical work were related to the notion of science literacy. As such, this chapter indicated that the main purpose of science teaching and practical work was seen by the participants as the students learning the content and process understanding, and developing skills in science which they will use in their everyday lives. Moreover, the participants' views indicated that the design of the school-based assessment is reasonable but there was narrow perception of what it aimed to assess, as well as why and how it going to assess. The participants' views also indicated that there were limitations in the implementation of school-based assessment, especially with regards to science

teaching resources, class sizes and teachers' ability. The findings suggested that there should be flexibility with wider consultation and teacher professional development and involvement for the design and implementation of school-based assessment.

The next chapter will discuss these findings with respect to relevant literature presented in Chapter Two and my own interpretations.

CHAPTER FIVE: Discussion of Findings

5.0 Chapter Overview

This chapter discusses the findings based on the analysis of the eight participants' views (Chapter Four), the literature review (Chapter Two) and my own beliefs, experiences and background knowledge as legitimated in the interpretive perspective (Chapter Three). Firstly, the findings about the aims of science teaching, scientific methods and roles of practical work are discussed. Secondly, the findings about the purpose, design and implementation of practical assessment activities in the school-based assessment (SBA) for the Solomon Islands School Certificate (SISC) are discussed. This is followed by the summary of this chapter.

5.1 Introduction

This discussion develops an analysis of the participants' views of the purpose, design and implementation of practical assessment activities in the SBA for the SISC. Practical work as an assessment activity is one of the main components of the science SBA which begins in Form 4 (year 10) and is completed in Form 5 (year 11) the following year. All Form 4 and 5 students in all secondary schools in Solomon Islands undertake SBA as part of their internal assessment in Science towards the national SISC. The aim of science SBA is to assess the practical skills that cannot be assessed using written examinations. SBA is compulsory and a prerequisite for students to sit for the final SISC written examination at the end of Form 5. With such purpose and context this discussion was guided by the following research questions:

1. What are the views of the participants with regards to the purpose, designs and implementation of science practical assessment activities in the SBA for SISC?
2. How do the participants view the science practical assessment activities in the SBA with regards to their beliefs and experiences in science teaching, learning and assessment?

3. What changes do the participants suggest for the design and implementation of science practical assessment activities in the SBA for Solomon Islands School Certificate?

The findings of this study indicated that the participants had concepts, experiences and views about the aims of science teaching and the roles of practical work. They had views and concerns about the manageability of science SBA which include science teaching resources, class sizes and teacher professional development. This was similar to other studies overseas. Nevertheless, the findings indicated that the participants' views about the nature of science and assessment of practical work in the context of SBA were narrowly expressed, especially in relation to notions of reliability, validity, use of formative and summative assessments with respect to theories of learning and the standardization of assessments for high stakes reporting.

I have decided to construct a discussion which not only answers the research questions but also considers issues pertinent to the use of practical assessment activities in the context of SBA in Solomon Islands science education. In fact, the discussion of assessment cannot be divorced from the discussion of teaching and learning or the aims of curriculum and its political context (Bell, 2007). This is a more coherent approach to discuss teaching, learning, assessment and curriculum (Hayes, 2003). It is with regard to this principle that I will discuss the findings.

5.2 Findings about Science Teaching, Scientific Methods and Practical Work

The findings in this section are discussed to develop an understanding to interpret the findings in the next section (5.3). Firstly, the findings on the aims of science teaching are discussed. Then the findings on the views about scientific methods are discussed, followed by the roles of practical work.

5.2.1 Aims of Science Teaching

The findings indicated that the participants saw five aims of science teaching: (1) for acquisition of basic science concepts and skills; (2) for development of inquiry skills and understanding; (3) for awareness and being holistically informed; (4)

for addressing a human need and (5) for fulfilment of the science syllabus and prepare students for national exams.

5.2.1.1 Science in the Curriculum

The findings indicate that science teaching is seen as purposely to educate students to construct content and process understanding and skills in science to help them cope with activities and decision-making that they will encounter in their everyday lives. For example, four participants commented that students should be able to relate or apply the science concepts and skills they learn in their daily lives. Three participants perceived that inquiry skills and understanding in science are vital for students to solve problems in their everyday lives which are surrounded by science and technological artefacts and processes. Moreover, five participants mentioned that awareness and holistic development in science is significant for students to be able to make responsible and informed decisions in all aspects of their lives. One participant commented on the aim of addressing a human need in science teaching which also relates to the notion of science literacy.

These views were also expressed by participants in similar studies overseas both in developing and developed economies. For example: A study on 90 beginning science teachers in Turkey by Gezer and Bilen (2007) showed that a majority of the teachers viewed that science teaching must be related to daily life. The perception of teaching science content for everyday contexts was quite prevalent in many studies, as well as the notion of teaching science for awareness and acquiring problem solving skills. This is in line with the perception of science literacy which influenced the trends in the 'Science for All' concept in the United States and the Public 'Understanding of Science' in the United Kingdom (Duschl, 2008). Similarly, one of the rationales of science education in the Solomon Islands is science literacy (MEHRD, 2007a). Hence, the findings indicated that the participants in this study perceived science teaching more or less the same as other participants in other studies.

These views are related to the three learning elements that Hodson (1998) considered in science education in association to the notion of science literacy. The three elements are learning science, learning about science and doing science. He explained that learning science is associated with students acquiring and

developing conceptual and theoretical knowledge in science. This includes learning factual information, understanding relationships, recognising phenomena and developing basic manual skills that can be related to and used in everyday encounters. Learning about science involves developing an understanding of the scientific methods, science history and development, as well as the awareness of the interaction science has with technology, society and the environment. Doing science involves "engaging in and developing expertise in scientific inquiry and problem-solving" (p. 5). These elements of learning in science, according to Hodson (1998), focused more on personalising learning which is person oriented, taking into account the humanistic aspect of learners. The underlying intention is for personal enhancement for life (De Boer, 2000).

On one hand, the notion of scientific literacy has influenced the growing recognition that activities in science classrooms need to involve the discussion of socio-scientific issues which are important to prepare science literate citizens (Laugksch, 2000). On the other hand, according to Sadler and Zeidler (2009), science literacy has the vision which emphasized the idea of learners using science in their everyday life contexts. This has invited progressive movements in science education, especially with respect to science teaching, learning and assessment. The progressive movements considered science and science education as a human social activity which is occurring within a social, cultural, political, historical and economical framework within a classroom of students with different socio-cultural backgrounds (Lemke, 2001). So, the nature of interactions between teachers with students, and students with students is theorised and tailored in association with socio-cultural and political processes. Such interactions involve teaching, learning and assessment which are more purposeful, intentional, situated, contextual and collaborative, using language and artefacts that are meaningful to communicate (Bell, 2007). Having such ideas about teaching, learning and assessment in science education are significant in achieving the aims to teach science content, skills and processes for everyday contexts.

However, the findings of this study indicated narrow views held by the participants on the underlying learning theories and rationales in science teaching which justifies the aims suggested in the findings. Only three participants indicated why the aims of science teaching were focused on teaching science for

everyday contexts. Mata, Hans and Wane mentioned that science teaching for an everyday context involves teaching science to help students to think logically and have the ability to analyse problems and issues of various natures, such as AIDS, climate change, sustainability of environment, food and security and natural resources. Despite the reasons and explanations given, the participants did not mention the theories or the philosophical explanations, for example, science for all, that had shaped the aims of science teaching as suggested in the Solomon Islands science curriculum and SBA.

According to Millar (2004) and Hodson (1998), there are two distinct aims of science. One encompasses the idea of science literacy and the other is the traditional aim of educating students for selection into higher levels of education in science and for science-based careers. These two aims are important, according to Millar (2004), since they lead to different criteria for selection of science content, different approaches and emphasis in teaching, learning and assessment and different rationale for the use of practical work. The second aim mentioned here was not clearly expressed by the participants in this study, though Hans commented on students having to be educated in secondary school science to be able to comprehend science at the university level. Hans' comment was in reference to his view and concern about students' skills in being able to perform science practical work at the university science level. This view was not part of the aims of science teaching rather it was a view concerning the role of practical work which I will discuss later in this chapter. Nonetheless, the point I want to stress here is related to the one that Millar (2004) made about the notion that different aims of science teaching lead to different criteria for content, approach and emphasis and purpose for practical work. This point is significant to this study, since the findings about the aims of science teaching only vaguely indicated the aim for selection into higher education level and to science-based careers. This means the criteria for selection of science content, approaches in teaching and assessment and the purpose of practical work in this study are inclined towards the aim for science literacy.

This is most appropriate in the Solomon Islands where many students finish their formal secondary education at the end of Form 5 and only a few go on to study science in Forms 6 and 7 and later go on to tertiary education in science. For

instance, according to the context of this study in section 1.4.3, about 56 percent of Form 5 students in Solomon Islands in 2009 will go on to do Form 6 in 2010 while 54 percent will finish formal secondary education. Fensham (1985) said that science-for-all or for everybody in everyday contexts should be taught up to Form 5. He said, after Form 5, those who want to specialise in science or science-for-future scientists and related careers need only to be taught from senior high school and onwards, for example, Forms 6 and 7 and at the tertiary level.

Hence, there are few points I want to stress in this discussion about the aims of science teaching indicated in the findings. Firstly, as I have discussed earlier, the aims of science teaching in these findings were more related to the notion of science literacy which had more emphasis on three learning elements in science and are focused on learners' use of science content, skills and processes in an everyday context. Secondly, there was little mention of the aim of science teaching for selection into a higher level of education science and for science-based careers. Finally, with the first point there was no indication in the findings about the theoretical perspectives that underpin the reasons for teaching and how to teach and assess for everyday context. However, there were indications with regards to the idea that modern societies are influenced and surrounded by artefacts and issues relating to science and technology. These points are significant to this study because teacher understanding about the different aims in science teaching and the different factors that influenced the aims will lead to the understanding of the different criteria for science content, different purposes for practical work and different approaches in teaching, learning and assessment in science (Millar, 2004).

5.2.1.2 Expectation of Teachers

The other aim of science teaching identified in the findings of this study was fulfilling the science curriculum and preparing students for exams. This aim was stressed by three participants. Sam, Jen and Hans all mentioned the obligation to follow and complete the required science syllabus. Jen specifically stressed that the main aim is to prepare students for tests and exams. This finding is interesting to this study since three out of the eight participants mentioned this view (almost half).

Similar studies conducted by Lynch and Ndyetabura (1983) in Tasmania and later Wilkinson and Ward (1997) in Victoria, Australia, indicated that the aim of science teaching to prepare students for exams and tests was seen as the least important compared to other aims of science teaching. The indication that it was least important in those two studies reflected an education system (in those states) which had minimal high stakes examinations, a more decentralised curriculum, as well as less emphasis on overall assessment purposes (Wilkinson & Ward, 1997). On the other hand, it can be inferred that, more emphasis on such an aim reflect a system which has high stakes examinations and a heavily prescribed and centralised curriculum. Such views were expressed by teachers in Hong Kong which had an examination-oriented educational system (Yung, 2001). In such educational systems, teachers' decisions on what and how to teach and assess in the classroom is dictated by what is prescribed in the curriculum and is expected from the stakeholders and politics, particularly for the sake of accountability (Parkinson, 2004; Yung, 2001). We can infer that within the context of the Solomon Islands exam-oriented educational system this finding showed that the participants of this study viewed the fulfilling of science curriculum and preparing students for exams as an expectation to fulfil. I assume that was the reason why three out of eight participants voiced this aim of science teaching in this study.

Similarly, Saeed (1997) found that in the Maldives, teachers were pressured to cover the science curriculum content. They viewed students' passing of exams as a success and a reflection of effective teaching. Abrahams and Saglam (2009) also found in England and Wales that assessment procedure for accountability did influence teachers to consider the aim of preparing students for exams as important. Having these explanations, we can infer that the participants in this study were also faced with expectations outlined in the Solomon Islands science curriculum.

Interestingly, this finding reflected an education system which is heavily exam-orientated with high stakes assessment purposes. In the Solomon Islands, the education system is exam-oriented with many external summative examinations held at different education levels, for selection purposes. For example, Solomon Islands Form 3 national examinations at the end of Form 3 and Solomon Islands School Certificate at the end of Form 5.

5.2.2 Scientific Methods

The findings showed that five out of eight participants viewed scientific methods as similar to practical work in school science and the other remaining three viewed it as a systematic way of doing science. These two views are related. Practical work in the SBA for SISC to which I assume the five participants referred to as similar to scientific methods, are heavily prescribed with steps to be followed by students (*see Appendix B*). The steps are systematic, beginning with a hypothesis followed by sequential and discrete steps. Students are expected to follow instructions in order to reach a predetermined outcome. Hence, the practical work that the participants referred to was designed with systematic steps. So, we can infer that the two views on scientific methods in this finding are related. That is, scientific methods were perceived as a systematic way of doing science which resembled the predesigned practical work in school science in Solomon Islands science education context.

A similar finding was reported by Tang, Elby and Levin (2009) in one of the secondary schools in Atlanta, United States of America. They reported that, in a typical science classroom, scientific methods were usually perceived and practised as an ordered way of science inquiry with discrete steps to be followed in the right sequence. Their study indicated that such a view and practice of scientific methods compromised students' authenticity in conducting ongoing productive science inquiry. As well, it took away the teachers' focus from students' productive science inquiry to rigidity in following instructions and getting correct answers to activities. Tang et al. (2009) claimed that such perceptions and practice in scientific methods also influenced the teachers' beliefs and expectations in the assessments of such routine and systemic practice. They said that students in such an environment also had the expectation to follow the routine practice of scientific method and its assessments.

Similar trends of perceptions and practices were seen in other countries such as Australia, Sweden, United Kingdom and Scotland and were also echoed in New Zealand in the 1980s (Haigh et al., 2005). Haigh et al. (2005) made mention of the notion of the recipe type of practical work which depicted scientific methods or science inquiry as following a recipe with discrete and sequential steps. According

to Wellington (1998), this was one of the legacies of practical work in the first movement of practical work in the United Kingdom in the 1960s to 1980s. Ironically, he claimed that many science classrooms in England and Wales had those same standard practical activities which were passed on to pre-service teachers and even through laboratory technicians. Jenkins (1998) agreed that even the so called 'planned investigation' or the 'investigation by order' in the late 1990s was a reflection of a similar legacy of a systemic way of doing science. This perception and practice had led to standard forms of assessments in practical work which assessed students' ability to follow instructions, a discovery learning perspective. Subsequently, Wellington (1998) called for a reappraisal of practical work.

That said, I would admit that prior to undertaking this study I had a similar perception to those of the eight participants in this study. This view of practical work was a legacy from when I was a secondary school student in the late 1980s and through my university studies in physics at the University of South Pacific in the early 1990s. As a science teacher, this view was what I taught and instructed my science students. I assume the findings about the notion of scientific methods in this study were similar to my own preconceptions. As such, we may infer that the findings could also indicate that the participants' beliefs and conceptions of scientific methods were shaped by their experiences as students and as pre-service teachers (Wellington, 1998). We might also infer that the participants' views about the assessment of practical work might also be influenced by their views about scientific methods.

Nevertheless, many studies, for example, Abrahams and Millar (2008), Hodson (1998), Millar (2004), Parkinson (2004), Wellington (1998), explained that there is no one scientific method or one particular way of doing science. For example, Wellington (1998) asserted that science has methods but not just one method. He continued to say that scientific method does not follow a set of steps but it involves tacit, implicit and personal knowledge influenced by socio-cultural factors. Given that there is no one scientific method, Millar (2004) and Wellington (1998) both thought that there are different types of practical work with different purposes to achieve different aims of science teaching. Hence, they said the understanding of scientific methods or the nature of science is fundamental to

understanding the roles and learning outcomes of different practical activities. The next subsection discusses the findings on the roles and the learning outcomes of practical work.

5.2.3 Roles of Practical Work

The findings indicated that the participants saw four roles for practical work. They were (1) For conceptual understanding; (2) to develop manipulative skills in science; (3) to develop procedural understanding; and (4) to develop attitude in science. These roles of practical work can be grouped into three main domains categorised by Wellington (1998). The three domains are cognitive, affective and skills. I will discuss these in turn.

5.2.3.1 Cognitive Domain

All the eight participants had the perception that a role of practical was to develop conceptual understanding. They all said that when students visualised and performed hands-on experience in science, they would have better conceptual and theoretical understanding because they could affirm what they learned theoretically. For instance, Dan, Hans, Wane and Liam stressed that practical work provides an opportunity for students to actually touch, see and handle things which they theoretically learn in science classes. That provided opportunities for the students to concretely affirm what they learn theoretically. This view was also indicated in a study conducted by Saeed (1997) on seven Maldives and five New Zealand science teachers about their views on practical work. She found in her study that both groups of teachers talked about the idea that practical work provides concrete experience for students to learn science concepts that may not be familiar to them. Similar findings were also made in Sweden (Ottander & Grelsson, 2006) and in United Kingdom (Abrahams & Millar, 2008). This indicated a similarity between the views of the eight participants in this study with other participants in other contexts.

However, Hodson (1998) and Wellington (1998) argued that not all practical work can promote concrete affirmation of concepts and theories. In fact, Hodson (1998) claimed that the concreteness of practical work can also distract the students from learning concepts and theories. Similarly, Wellington (1998) explained that

practical work can also confuse students as easily as it can illustrate and clarify an idea. Therefore, practical work can also be a hindrance instead of promoting student acquisition and understanding of science concepts and theories. To address this, Millar (2004) explained that a practical work that intended to teach science concepts should be specifically designed to achieve such learning outcomes.

Corresponding to the aim of teaching science for conceptual understanding and role of practical work for cognitive development, five out of the eight participants perceived that the learning outcomes for practical work should be that, students should be able to demonstrate their understanding of the concepts and the theories of science. Nevertheless, learning outcomes such as to learned concepts, theories and relationships cannot be easily achieved in recipe-book or self discovery practical work (Millar, 2004). Likewise, Hodson (1998) explained that to teach concepts, theories and relationships in science requires scaffolding from teachers. He said, these are not facts and objects that can be easily visualised, memorised and recalled, rather they are ideas which need to be communicated in a meaningful way for the students to learn and understand. This was also supported by Abrahams and Millar (2008), who pointed out that the aim of practical work is for the students to make links between the world of objects and the world of ideas.

Scaffolding for such learning outcomes involves teachers addressing students' prior knowledge (De Jong, 2007; Duit & Treagust, 2003; Vosniadou, 2002). To facilitate the restructuring or reconstruction of students' prior knowledge, the structure of scaffolding in the practical work requires contextual links between what is experienced from everyday encounters and the intended science concepts to be learnt (Millar, 2004). The difference of bridging this gap is what Leach and Scott (2002) referred to as the learning demand. This means, to learn concepts, theories, or relationships in practical work, scaffolding needs to involve addressing the learning demand. Scott (2005), explained that, in science learning, the learning demands need to be identified and addressed using everyday language, artefacts and social processes.

Hence, the process of achieving conceptual change is not only based on reasoning but is embedded in social processes with social consequences (Lemke, 2001).

That means, to teach science concepts in science classes or through practical work, scaffolding should involve social interactions which are situated, purposeful and collaborative using language and artefacts contextual to the students (Bell, 2005).

5.2.3.2 Skills Domain

Another role of practical work indicated in the findings of this study was related to the purposes of developing manipulative and inquiry skills in science. Seven out of the eight participants commented on the role of practical work to develop manipulative and transferable skills while only one participant clearly expressed the view about developing inquiry skills in science. Again, the findings in this study resonated with similar studies in other contexts. For example, Ottander and Grelsson (2006) found that their four upper secondary science teacher participants in Sweden had the view that practical work was also for students to practise laboratory skills and techniques. Similarly, Saeed (1997) found that both New Zealand and Maldives teacher participants expressed their views about the development of practical skills in practical work. The practical skills included technical, personal and social skills, following instructions and developing inquiry skills. Interestingly, Saeed (1997) also found that none of the Maldives teachers expressed the view about developing inquiry skills while some New Zealand teachers expressed enthusiasm for open investigation in school science. As mentioned earlier, only one participant mentioned the view about developing science inquiry skills. I assumed it was because of her pre-service education in New Zealand. The other seven participants commented more on developing manipulative skills in practical work. This may be a reflection of the Solomon Islands science curriculum, assessment and participants' pre-service science education which lacks emphasis on developing inquiry skills.

In line with the view of developing manipulative and transferable skills as an aim of practical work, three participants mentioned the learning outcome which included the demonstration of such skills in practical work by students. For example, Dan and Hans commented that in practical work students should be able to use different science equipment appropriately, correctly identify and name objects and to develop technical skills. In addition, four participants mentioned the learning outcomes in practical work which demonstrated students' ability to

follow instructions and demonstrate transferable skills such as observation, prediction and making inferences. Practical work with such aims can be described as a cookbook (Llewellyn, 2005) or a recipe type of activity (Wellington, 1998). The learning outcomes in such types of practical work, according to Millar (2004) can be easily achieved by designing an activity that does not necessarily mimic real science. For example, he argued that students may be able to identify objects, visualise events and learn facts through observing teacher demonstrations, video shows about a phenomenon or displaying of items. Hence, different types of practical work can be specifically designed to achieve different learning outcomes of such nature.

In this study the findings indicated that although seven out of the eight participants alluded to and only one actually mentioned the idea of developing inquiry skills and understanding, no participant used the term, 'nature of science'. Similarly, a study conducted by Akerson et al. (2009) on 17 K-6 elementary teachers in Atlanta, United States of America found that most teachers had narrow views or misconceptions about the nature of science. They found that some participants had views which related the nature of science to the science body of knowledge. They claimed that many of their participants changed their views about the nature of science during the course of their study. However, some of their participants made little change. They assumed it was because of other external factors such as the teachers' prior experience and pre-service and in-service training. Akerson et al.'s (2009) findings were significant to the findings of this study although there may be huge differences between the contexts of their study and this study. However, I want to highlight two significant indications. Firstly, their participants' misconceptions of the nature of science and secondly, the fact that some participants' beliefs were heavily influenced by their own experience in teaching and training in science education. On the same note, we can infer that the findings in this study indicated that the participants lacked knowledge of the nature of science and this can be a reflection of their past experience and teacher pre-service and in-service training.

The trend in teaching scientific methods in school science is shifting to open investigations (Haigh et al., 2005; Roberts & Gott, 2006). A study was conducted by Haigh (1998) in New Zealand on how students can gain better understanding

about scientific methods and the nature of science in doing open investigations. A key finding was that students needed to be specially taught how to do open investigations. A similar study was also conducted by Pekmez, Johnson and Gott (2005) with teachers in England and Wales. Both studies suggested the importance of educating pre-service and even in-service teachers about the nature of science so that they can teach school students scientific methods in open investigations. Moreover, both studies recommended that the aims of science teaching and the assessment procedures should reflect such a focus on open investigations. In line with this view of open investigations, Mata was the only participant who also mentioned that students in the context of this study should be given problem solving types of practical work. She said such practical work should encourage students to identify problems then plan and design activities to find solutions to the problems. In other words, students should develop their understanding of the nature of science when doing practical work.

According to Haigh (2007), open investigation promotes creative thinking and procedural understanding. However, she said teachers' careful planning and insightful thoughts about students' involvement in such activity is crucial. She raised some questions about how to accommodate such activity within a rigid curriculum framework; how to assess students' achievement for accountability; how to address the difference between teaching for creativity and conceptual understanding; whether teachers need to be creative to teach or facilitate such activity; and how science teachers creativity can be developed and nurtured to administer such open investigation in school science practical work. Abrahams and Saglam (2009) found in their study in England and Wales that although open investigations were a part of the National Curriculum they were rarely used to teach students about science inquiry. Instead empirical inquiry was used predominantly. They claimed this was because the assessment of open investigation may not satisfy what is required in public examinations for summative assessment purposes. This has implications for the SBA of practical work for Solomon Islands School Certificate (SISC).

I feel that this claim by Abrahams and Saglam (2009) is significant to take heed if open investigations are to be used in the case of science school-based assessment. Likewise, the questions raised by Haigh (2007) concerning teachers' ability to

plan, facilitate and assess open investigations are crucial if such practical activities are intended for SBA for the SISC. On the other hand, if open investigations are to be used in the SBA, then there should a match between the aims of science curriculum, purposes and practices of practical assessment activities and teachers' pedagogical content knowledge (Bell, 2007) in the SBA for the SISC.

5.2.3.3 Affective Domain

This section discusses two aspects of practical work: (1) to help students develop scientific attitudes, for example, open mindedness and suspended judgement; and (2) to motivate students to learn science. For the first aspect, Dan talked about the development of attitudes in science as a role of practical work. But rather than talking about open mindedness and suspended judgement, he was using the term to talk about developing students to have a positive outlook and value the science skills and knowledge they acquired in science teaching and practical work. Pam argued that students should develop honesty and truthfulness when doing science because science is about relating information or scientific findings. For the second aspect, Hans commented on the view that science teaching should motivate students to continue to do science in their everyday lives and also to be creative. The findings in this study with respect to the affective domain in practical work lacked clarity and detail. This may have been due to the nature of the open-ended interview questions and less in-depth probing.

These findings on the role of practical work in motivating students can be related to other findings indicated in similar studies overseas. For example, studies conducted by Pekmez et al. (2005) in the UK, Wilkinson and Ward (1997) in Australia, and Saeed (1997) in the Maldives and New Zealand. All these studies found that one of the important roles of practical work expressed by their participants was to make science interesting, enjoyable and to motivate students to do science. Saeed (1997) commented on the idea of motivating students to stay in science not because of the intrinsic values of science itself but for science literacy. Based on the findings of this study on the aims of science teaching for everyday contexts, we can also infer that the findings on the affective aspect of practical work can be viewed in relation to the notion of science literacy. That means the development of the affective aspects through practical work were not only for

intrinsic reasons or to lead towards science-related careers but they were also for developing a science literate citizen. In fact, not all students will be interested or motivated when they study science or do practical work for the purpose of selecting a career in the future. However, with the aim of science teaching for science literacy, students need to be motivated to study science and do practical work for the sake of the value that science would have to their daily and civic lives.

Nevertheless, according to Hodson (1998) and Wellington (1998), practical work can also easily distract and de-motivate students. They said students can be put off if they think that the practical work is not relevant to them. Moreover, they can be de-motivated if things go wrong during the practical work.

Learning, learning about and doing science to be a science literate citizen requires student enculturation in science (Hodson, 1998). Enculturation is seen as a process of inducting, in this case, students, into the world of science: its practices, language and ways of argumentation. It is a socio-cultural process to enable students to operate both in the everyday world and in the world of science (De Jong, 2007; Duschl, 2008). That means, in order for practical work to motivate students and to develop positive attitudes in science, it has to be designed to promote meaningful enculturation into the discipline of science.

These findings about the aims of science education, scientific methods and the roles of practical work are significant as they can be used to interpret and discuss the findings about the assessment of practical work in the SBA for the SISC.

5.3 Findings about the Practical Assessment Activities in School-Based Assessment (SBA) for the Solomon Islands School Certificate (SISC)

The findings on what is assessed, the design and implementation, and the suggested changes in the SBA for the SISC are discussed as a whole in this section. The findings are discussed in terms of the quality of the SBA for the SISC since this study was aimed at exploring and documenting findings that can be used to improve the quality of the SBA. As such, this discussion relates to the issues of validity and reliability in the context of SBA.

5.3.1 Validity of the SBA for the SISC

There are many forms of validity in educational assessment (Bell, 2007; Harlen, 2005b). However, one of the main forms of validity is concerned with whether the assessment task actually assesses what it intended to assess (Black & Wiliam, 2006) and whether the assessment is trustworthy (Cowie, 2000). The findings indicate that the participants thought that the validity of the SBA would be enhanced by refining its design and employing the interactive use of formative assessment and summative assessment (Harlen, 2005b).

5.3.1.1 What is assessed in the SBA for the SISC

The findings indicate that the SBA is seen to be assessing different aspects of students' learning and development in science. Five out of eight participants said that the practical assessment activities were assessing students' understanding of the science concepts they have learnt in science classes. Two participants mentioned that SBA is assessing students' skills in doing science, while one participant saw that the SBA is assessing the learning outcomes that are stated in the SBA handbook. This indicated that there was discrepancy in what the participants viewed as the purpose of the SBA. According to the SBA handbook (*see Appendix A*), the overall aim of the SBA is to assess the skills in science that are difficult to assess in written examinations.

The findings indicate that the design of practical assessment activities in the SBA was one of the factors seen by the participants as influencing this discrepancy. For instance, Mata viewed the practical assessment activities as assessing the students' understanding of the science concepts because of the type of the assessment criteria in the SBA (*see section 4.3.1.1*). This is also evident in terms of mark allocation in the SBA handbook (*see Appendix A*). For example, 20 marks out of the total of 30 marks were allocated to students for answering and completing a report sheet for each practical task. However, whether the 20 marks allocated is justifiable and validly assesses the students' understanding of science concepts is another question beyond the scope of this study.

A study conducted in the United Kingdom suggested that evidence from paper and pencil reports are significant in assessing the students' "thinking behind the

doing" (Roberts & Gott, 2006, p. 63). Although paper and pencil reports did not assess students' performance, they provided the evidence of the understanding which was largely related to explaining the application of the scientific concepts to be clarified in the practical work (Roberts & Gott, 2006). This was also found in a study by Ottander and Grelsson (2006) in Sweden. They found that students' practical work was assessed by how they presented their reports and not how they displayed the required skills. However, whether the students can relate what they actually do with the materials in the practical work to the concepts they have learnt is another consideration beyond the scope of this study.

Indeed, to assess students' understanding of scientific concepts in practical work, students have to learn the concepts and relate them to the material world beforehand (Millar, 2004). However, many students cannot easily relate the ideas behind the materials and the phenomenon they are experiencing in practical work (Millar, 2004; Wellington, 1998; Hodson, 1998). Hence, teaching science concepts and relating them to the material world often requires scaffolding (Hodson, 1998). This involves formative assessment which aims to improve students' learning of the intended learning outcome. In science learning, this involves teachers giving feedback and feedforward to address students' misconceptions in order to close students' particular learning gaps (Green & Johnson, 2010). However, this is not the aim of the SBA for the SISC as stated in the SBA handbook; its aim is to assess students' skills for summative purposes.

Only two participants mentioned that SBA is assessing students' skills in science (*see section 4.3.1.2*). They said the skills included students' ability to follow instructions, handle science apparatus, interpret data, make observations and record results from practical work (*see Appendix A–section 7.0*). The assessment of these skills is worth 10 marks and it is added to the other 20 marks from completing the report sheet, to make up the total of 30 marks for each practical assessment activity. The mark allocated for assessing skills indicates that the SBA is designed with less emphasis on the assessment of students' skills which is purported to be its primary goal. In addition, there are no instructions in the SBA handbook (*see Appendix A*) to explain or describe how these skills are going to be assessed, whether the teachers assess these skills on the spot as the students do the

tasks by observing them or by allocating marks on students' performance by impression marking after they have completed the activity.

The findings also indicate that the weightings for the research project compared to the nine Pupils Performed Assessment Practical (PPAP) in the science SBA are not seen as fair, in terms of the amount of work and time versus the allocated marks. For instance, although students take nearly a year to complete their research projects, their weighting towards the science SISC is just 5 percent of the total 20 percent in the SBA, compared to practical work which is done within 50 minutes for each assessment task. In addition, the marking criterion for the research project is also by impression marking, since allocated marks are given in a range. Hence, the weighting for each skill assessed depends on how each teacher interprets and judges the completed practical assessment activity. In fact, a study conducted by Lal (1991) with Form 6 chemistry teachers in Auckland, New Zealand about the assessment of practical work in chemistry found that teachers were against using impression marking to assess practical work because it was too subjective. There was too much room for variance between teachers; moderation was necessary to ensure comparability. However, to some of the teachers, that was seen as undermining their professional assessment abilities (Lal, 1991).

The skills indentified to be assessed in the SBA handbook for both research projects and practical work are associated with the discovery learning theory (Wellington, 1998). However, students tend not to discover things for themselves when they are left alone to follow instructions and to infer or deduce a scientific conclusion (Pekmez et al., 2005). This is a naive inductive view of science learning whereby students are expected to develop ideas from conducting the processes in practical work (Hodson, 1996). In fact, students use their prior knowledge to make sense of phenomena and to discern what a worthwhile result is during the practical work (Hodson, 1998). Moreover, Hodson (1998) asserted that the skills mentioned in a discovery view of learning are a means to an end. Such skills need to be enhanced by the conceptual and procedural understandings in order for them to be used effectively in doing science.

According to Millar (2004), there are two types of effectiveness in practical work. One involves the effectiveness of students doing what they are supposed to do.

The other involves the effectiveness of whether the students have learnt what they are supposed to learn. The skills are presented as what the students are supposed to do and how they perform them. The conceptual understanding is reflected in what the students actually learn, and whether they can explain the concepts or relate them to other contexts (Hodson, 1998; Millar, 2004). Given these two types of effectiveness, the practical assessment activities in the SBA should clearly identify the focus of the assessment. If they are to assess the skills then students should be assessed on what they actually do (that is perform) in the practical work. On the other hand, if they are to assess their understanding of scientific concepts then students should be assessed on what they learn. However, as discussed earlier, learning science concepts and relationships in practical work requires scaffolding which primarily uses formative assessment.

5.3.1.2 Inadequate Practical Assessment Tasks

The findings indicate that the participants think there is an inadequate number of practical assessment activities in the SBA. The inadequacy of assessments was related to both the number and the types of practical assessments activities in the SBA (*see section 4.3.1.4*). The findings suggest that there should be more practical assessment activities in the SBA which aim to assess different aspects of students' learning of scientific concepts and performance of skills (*see section 4.5.2.5 & 4.5.4.1*). This means that there should be different types of practical work with different learning outcomes (Millar, 2004). As such, students are assessed appropriately according to what they are supposed to be assessed for. For instance, the findings suggest that for the assessment of students' performance skills, the practical work should be designed such that the students' skills are assessed on the spot and not after, in a written report (*see section 4.5.2.2*).

5.3.1.3 Enhancing the Validity of the SBA

The findings suggest that the participants thought that the validity of the SBA could be improved by redefining its purpose and redesigning its schedule and marking criteria. For example, the findings discussed in section 5.2 suggested that the participants thought that SBA can be improved by utilising practical work to teach and assess for the nature of science which involves teaching and assessing for conceptual and procedural understanding. This is one of the aspects of

teaching for science literacy (Duschl, 2008). Science literacy is also a rationale for science education in Solomon Islands (MEHRD, 2007a). Subsequently, open investigations can be used to teach students the nature of science and to develop their conceptual and procedural understanding which would enhance their science inquiry skills (Haigh, 2007).

Open investigation was also suggested in the findings by the participants. Three out of the eight participants suggested that SBA should include more assessment of open investigations whereby students can be assessed on their inquiry skills of planning, designing and carrying out their plans and making claims from their findings (*see section 4.5.2.1*). This means that practical work which provides such learning experiences should be a significant component of science teaching in the SISC science syllabus. Such learning experience require meaningful and intentional scaffolding and enculturation (Bell, 2005; Haigh, 1998) as discussed earlier in section 5.2. This form of learning experiences requires a shift to utilise a more formative form of assessment. This view was also indicated in the findings of this study (*see section 4.5.2.3*). This is a vital mechanism to enhance conceptual and procedural learning. This involves teachers giving trustworthy feedback and feedforward. It is a dialogic process which takes place during scaffolding and enculturation (Hodson, 1998) which is emphasised in the socio-cultural view of learning (Cowie, 2005).

The findings suggest that the marking schedule and criteria can also be changed to improve the validity of the science SBA. One participant suggested that assessment and marking can be done in phases after the students complete one of the stages in an open investigation (*see section 4.5.2.6*). Assessment in each phase can be for continuous summative assessment purposes. However, assessment information from each phase can also be used for formative purposes for the next phase. Hence, students learning can be improved from one phase to another in closing the gap in what is currently known to what is intended to be learnt and developed (Cowie, 2005). Moreover, teacher scaffolding in providing feedback and feedforward can also be trustworthy in the sense that students develop trust in the teacher to guide the learning.

The quality of such improvement or changes can only be enhanced if teachers themselves are professionally knowledgeable and competent (Shulman, 1987). This requires ongoing teacher professional development especially with the notion of pedagogical content knowledge (PCK). This was also indicated in the findings of this study (*see section 4.5.4.5*). That is, teachers need to continuously enhance their knowledge in connecting science content, aims of science teaching, roles of practical work, the diversity of students and classroom pedagogy and assessment (Park & Oliver, 2008).

Although there is overlap between validity and reliability (Black & Wiliam, 2006; Harlen, 2005b), I will now discuss the findings related to the reliability of the SBA for the SISC.

5.3.2 Reliability of SBA for SISC

The findings indicate that the science SBA for the SISC is seen as needing improvement to enhance its reliability. Although, reliability in terms of quantitative or statistical measures was outside the scope of this study, in this discussion, reliability is viewed as the notion of consistency in teacher and student understanding of the learning outcomes, and their familiarity with the practical assessment activities in the SBA (Green & Johnson, 2010).

The findings indicate that there were perceived inconsistencies within the science SBA for the SISC because of different interpretations, teacher ability, and lack of science resources in schools. The findings also suggested some ways by which the reliability of the SBA can be enhanced.

5.3.2.1 Different Interpretations and Teachers' Ability

The findings indicate that there was seen to be some inconsistency in the interpretations of what is assessed and the marking criteria for the SBA, thus influencing reliability. For a summative assessment task to be reliable, especially when different students do the equivalent assessment activity and are marked by different teachers, learning outcomes and marking criteria should be explicitly understood by both teachers and students (Green & Johnson, 2010). This can also be an issue of validity as discussed above. Therefore science SBA teachers need

to have a better knowledge and understanding about the aims of practical work, the learning outcomes and what to assess according to the marking criteria in the SBA. Teachers' inconsistency in the interpretation of the learning outcomes and the marking criteria can make assessment unreliable (Brookhart & Nitko, 2008). For example, in this study four participants viewed the SBA as assessing students' understanding of concepts while other participants viewed SBA as assessing students' skills. This is an example of how teachers may have different judgements when assessing students' practical assessment activities.

However, for consistency, although different teachers mark and make judgement on different students' performances and written reports in the SBA in different schools at different times, the assessment should still reflect some degree of similarity (Green & Johnson, 2010). The higher the degree of similarity, the higher the reliability and consistency.

Teachers' ability to carry out the SBA is also indicated in the findings as one factor that is seen to contribute to any inconsistency and lowered reliability in the science SBA (*see section 4.4.1.4*). This includes whether the science teacher is a qualified teacher or not, and whether the teacher implements the SBA confidently with high confidentiality and professionalism as viewed by Liam (*see section 4.4.1.4*). The findings suggest that most teachers were not able to submit their three Teacher Designed Assessment Practical (TDAP) and schedules to the science curriculum office for approval in time (*see section 4.4.1.4*). This meant that the curriculum office found it difficult to moderate the quality of the TDAP and the schedules that each Form 4 and 5 science teachers were using. This is significant as this is one of the main forms of moderation used (*see Appendix A-section 5.0 & 8.0*).

Students' views on the purpose, design and implementation of the science SBA were not within the scope of this study. However, findings also suggest that investigating students' experience and views on the issues related to science SBA for the SISC is significant to consider (*see section 4.5.1.2*).

5.3.2.2 Lack of Science Resources in Schools

A lack of science resources also contributed to lower the reliability or consistency. The findings indicate that some of the participants thought students doing SBA for the SISC were incapable of doing the practical assessment activities because they had not been taught and had not learnt the science concepts and processes, and had not developed the skills to be assessed (*see section 4.3.1.4*). I assume this could mean that there were several inconsistencies in the use of practical work in the school science classes and in the SBA. Either, some students from some schools had never used apparatus similar to apparatus used in the SBA or the SBA pre-designed practical assessment activities prescribed apparatus that was not available in some of the secondary schools in the Solomon Islands or some schools did not do practical work at all in their science teaching. We can therefore infer that the SBA is not reliable since the students are assessed in activities with equipment with which some of them were not familiar (Brookhart & Nitko, 2008). In fact, one of the participants mentioned that SBA should be implemented in the lower forms in the junior secondary school level.

The findings suggest that there were possibilities that all of these inconsistencies may exist (*see section 4.4.1.1*). One of the limitations that contributed to this inconsistency of students' unfamiliarity with predesigned SBA practical assessment activities is the lack of basic science equipment in many schools. The findings show that there is seen to be inconsistency in the implementation of the SBA. The findings indicate that participants thought there were high chances of both students and teachers making up false marks for practical assessment activities. As well, it was thought that there was a high likelihood of cheating amongst students in the same class since they had to work in large groups because of lack of equipment (*see section 4.4.1.3*). The lack of science equipment for doing practical work is a common issue that has been raised by many other studies, even in well developed economies (Wilkinson & Ward, 1997). It is always a problem with finance in the case of Solomon Islands (MEHRD, 2007c).

5.3.2.3 Enhancing the Reliability of SBA for the SISC

The findings suggest that the participants held a view that the number of practical assessment activities in the SBA should be increased (*section 4.5.4.2*). One of the

ways to address reliability is for the students to do the same activities many different times to get an average true score (Black & Wiliam, 2006). However, instead of doing the same practical assessment activities many different times, the findings further indicate that this can be modified by conducting many different assessment activities which aim to assess the same skills (*see section 4.5.2.4*). That is, different practical assessment activities can be designed to assess particular scientific skills at different times.

The findings indicate that to address the lack of science equipment in schools, the participants thought the SBA office (National Examination and Standard Units [NESU]) should supply science materials to schools for the six common assessment practicals (CAP) (*see section 4.5.4.2*). In that way, the six CAP should be conducted in different schools using similar materials. In addition, the findings suggest that the six CAP should be pre-tested (*see section 4.4.2.3*) so that the expected results can be determined. As such, the six CAP should produce the same expected results. This can also enhance the reliability of the SBA since most CAP will produce the same results whereby students' skills can be assessed according to similar judgements, especially with technical and precision skills.

Moreover, the curriculum officer participant mentioned that moderation was important to make a fair judgement on student samples for the science SBA. Moderation in the science SBA for the SISC is for high stakes assessment and it is done externally by external moderation panel as implied in Appendix A- section 17.

5.3.3 Other Worthwhile Findings

The findings also reveal that the safety of students and teachers in carrying out the practical work in schools was a concern to participants. This is also seen as a significant consideration with practical assessment activities in the SBA for the SISC (*see section 4.4.1.6*). The findings indicate the some of the practical assessment activities designed involved some chemicals that may be dangerous to teachers and students. Hence, safety was one of the issues to consider.

In support to the concern of safety raised by the participants, I believe it is of significance for the Solomon Islands Ministry of Education to formulate a policy

that would safeguard the design and the implementation of the practical assessment activities in the SBA for the SISC and the science education as whole. During my seven years of teaching science in two Solomon Islands national secondary schools, science teachers have submitted claims to the Ministry of Education to formulate a safety policy for carrying out science practical work in school science. However, as the findings imply, safety of both students and teachers is still a concern for the participants.

Summary of Discussion of Findings

The findings indicate that there was discrepancy in participants' views concerning what is assessed in the SBA for the SISC. As indicated in the findings, the factors that influenced the discrepancy include the design of the SBA and different teacher interpretations of the learning outcomes of the SBA. Also, the implementation of SBA had many constraints, such as, lack of science resources, large number of students, teacher abilities. For the improvement of quality or to increase validity and reliability in the SBA, the findings suggest some changes to its design and implementation strategies. These involve more teacher participation and teacher professional development, particularly in science pedagogical content knowledge (PCK). The findings indicate that students' perceptions are important to consider, as well as, the safety of both teachers and students in conducting the science SBA.

CHAPTER SIX: Conclusion and Implications

6.0 Chapter Overview

In the previous chapters, the findings of this study were outlined and discussed. This chapter concludes this study beginning with a summary followed by highlighting its implications and limitations. Then, suggestions for future research are outlined with a final reflection.

6.1 Summary of this Study

This research aimed to explore and document the views and experiences of seven Form 4 and 5 science teachers and one science curriculum development officer about the purpose, design and implementation of science practical assessment activities in the school based assessment (SBA) for the Solomon Islands School Certificate (SISC). Based on the interpretive perspective and semi-structured interview technique, this study generated qualitative data on the participants' beliefs and views about the aims of science teaching, scientific methods and the roles of practical work. This data was then used to interpret their perceptions about the purpose, design and implementation of science practical work as assessment activities in the SBA for the SISC. This study aimed to provide a contextual understanding that can be used to shape improvements to the purpose, design and implementation of practical assessment activities in the SBA for the SISC. It was also expected that the findings could be used improve the science education and curriculum in the light of the ongoing science curriculum reviews in the Solomon Islands, with the focus on outcome-based and student-centred learning.

The findings indicate that participants' beliefs and views about the aims of science teaching and the roles of practical work were mainly related to the notion of science literacy. That is, for students' learnt conceptual, procedural and skills in science to be used in the everyday contexts of their lives. This is the main aim in the Solomon Islands science curriculum for Forms 4 and 5, which is in line with the concept of outcome based and student centred learning with the aim to educate students for both academic and life skills pathways. However, the participants' views about the nature of science and assessment of practical work in the context

of SBA were narrowly expressed, especially with respect to assessing for science literacy and in an everyday context.

The findings indicate that there was seen to be a discrepancy in the interpretation of what is assessed in the SBA. The findings indicate that the aim of the science SBA was not seen as reflected in the design of the practical assessment activities, particularly in the report sheets and mark allocations. The main aim of science SBA for the SISC is to assess students' skills in science that cannot be easily assessed in external written examinations. However, the findings indicate that four out of the eight participants thought that, the SBA was seen to assess students' conceptual understanding rather than skills in science since conceptual understanding questions have more mark allocation in the SBA report sheets than the skills. In addition, the findings indicate that the science SBA was seen as highly prescribed with six common assessment practicals (CAP); three teacher designed assessment practicals (TDAP), and one research project. These practical assessment activities were seen to be unfairly weighted in terms of the amount of work and time students spend on different assessment tasks. The discrepancies seen in these findings were a threat to the validity of the science SBA for the SISC.

The findings indicate that some of the main constraints to effective implementation of the practical assessment activities in the science SBA were seen to be the lack of school science resources, as well as large class sizes and teacher ability. The findings indicate that many schools may not have the appropriate science equipment to conduct the SBA. Moreover, the findings indicate that the students had to do the SBA in large groups or through teacher demonstrations only, rather being assessed individually. This had provided short fall for teachers and students and they often had to resort to copying from others or from using past SBA practical report sheets. According to the findings, this was also related to the ability of the science teachers to perform their duties professionally and confidentially. These constraints were seen as contributing to the threat to reliability and inconsistency in implementing the SBA for the SISC.

From the findings, worthwhile considerations and implications were identified for the improvement of SBA for the SISC. The implications can also be significant to similar strategies in other subjects in Solomon Islands education as whole.

6.2 Implications

The findings of this study have several implications for the improvement of the SBA for the SISC. They implied that there is need to redefine the purpose of the SBA for the SISC. There is also a need to redesign the practical assessment activities. To be valid, the design of the SBA should assess what it theorised or intended to assess (Black & Wiliam, 2006). That means if it aims to assess students' skills alone then the practical assessment activities should be designed to assess the skills when they are practised and not afterwards. However, there are different types of skills: manual and manipulative and inquiry skills. The current aim of the SBA is to assess the skills that were emphasised in a discovery view of learning. This view, according to Wellington (1998), had distorted the nature of science because discovery is based on theories and not vice versa. The findings suggest that SBA should assess more of students' inquiry skills. This would be in line with the aim of science teaching for science literacy which also focuses on the outcome-based and student-centred learning approach. Hence, this study suggests that coherence in the aims of science teaching, the roles of practical work, and the design and implementation of the SBA is necessary.

Another implication arising from this study is that the SBA needs to address the dual concept of assessment. This suggests that SBA can be used for multiple purposes. This would also address the assessment of inquiry skills and the nature of science which are important to the student understanding and development in science for everyday context, as well as for academic progress in tertiary science-based studies and careers. SBA can be used for formative purposes to *improve* learning which involves scaffolding and enculturation in science. This encompasses the designing of SBA as an epistemic and social community of practice. SBA can also be used for summative purposes. That is to *prove* learning which involves practical and written tests. In addition, SBA can be used for accountability purposes which include reporting students' cumulative achievement throughout Forms 4 and 5 towards science in the SISC. The first two purposes of assessment can be used interactively in science teaching as well.

The findings indicate a request for wider consultation and flexibility with science teachers and students. This is to address the constraints of the lack of science

resources and teachers' ability to teach and assess students learning and development in science. The findings suggest that teachers should be given more responsibility and flexibility in designing the practical assessment activities (TDAP). If this is to be done, more effective moderation needs to be done. Moreover, teachers should be consulted when designing the CAP. The findings indicate that the number of practical assessments needs to be increased with different types of practical work with appropriate weightings to justify the amount of work done and time spent by the students.

Despite the changes suggested, the implications for the improvement of the SBA for the SISC rests on the ability of both science curriculum developers and science teachers to understand and effectively design and implement the complexity of the assessment strategies to address the aims of science teaching. Studies have indicated that SBA can be effective but it can also be value-laden and its reliability and validity is dependent on teachers' professional capacities and the moderation strategies (Bell, 2005; Fok et al., 2006; Selvaruby, O'Sullivan & Watts, 2008). For this, the notion of science pedagogical content knowledge (PCK) is a significant, especially with regards to its inclusion in pre-service teacher education and ongoing professional development (Bell, 2005, Shulman, 1987).

This study was the first of its kind in Solomon Islands, especially on science practical assessment activities and SBA. Hence, the findings and the implications from this study can provide contextual and valuable information for various stakeholders in Solomon Islands science education for developing effective science practical assessment strategies in the national science curriculum framework and in science education. That is, to design and construct practical assessment strategies that can be contextual, valid and reliable in the Solomon Islands science education context.

The information from this study can be used to support the assessment strategic framework emphasised in the Education Strategic Framework 2007-2015 (MEHRD, 2007b). Moreover, this study provides a framework for policy-makers and educators to recognize the significance of science practical assessment activities in Solomon Islands science education and ultimately to address the current notion of science literacy in the policy of education for all and for life.

This study is also in line with the ongoing development of the strategies for assessment advocated by the SPBEA. That is, this study provides significant information to the SPBEA's initiative to support and improve continuous assessment practices and assessment for learning in the Pacific. This study complements a Master of Education research study on teachers' views and values about formative assessment in secondary schools in Solomon Islands (Walani, 2009), and a Doctor of Philosophy research study on a professional development model for technology teachers in Solomon Islands (Sade, 2009). Both studies were conducted in Solomon Islands by two Solomon Islanders at the University of Waikato, New Zealand.

This study contributes to the existing literature on the notion of science practical work and its use in assessing students in science education. It provides information that can be used comparatively with other similar studies within Solomon Islands science education and within the wider Oceania region. In particular, this study provides a perspective from a context, which differs from those well- resourced studies and findings in the developed economies with well established science curriculum frameworks concerning practical work in science education. In other words, this study provides a perspective from the context of one developing economy where science education, let alone science practical assessment activities in SBA, was only implemented in the last decade.

6.3 Limitations

This study has its limitation. First, this was a qualitative study involving a small sample limited to eight science educator participants. This was about three percent of the science teachers' population teaching and conducting the science SBA for the SISC in Forms 4 and 5 throughout Solomon Islands in 2009. Hence, the views of the participants in this study can only reflect, but not represent, the diverse population of science teachers. Secondly, due to the nature of the semi-structured open ended interview questions, the responses were quite open even though probing was used to elicit more detail on a particular view that was worth noting. Thirdly, student perceptions were not investigated due to the scope of this study. In addition, time constraints and the fact that some of the SBA practical

assessment activities had not been done by the students when this study was undertaken in May of the school year.

In response to these limitations, I have suggested a few considerations for future research.

6.4 Suggestions for Future Research

For further research the following suggestions are worth considering.

1. In terms of sample size, a larger sample of teachers is suggested to generate representative quantitative data. This may involve considering the selection of teachers from rural schools and teachers with wide range of experience. The findings from the interviews in this study may be used to develop a questionnaire for a quantitative research.
2. Quantitative data and statistical analysis of the data could be undertaken to evaluate the validity and reliability of the science SBA.
3. Investigating students' views about the purpose, design and implementation of the science SBA for the SISC is significant, in order to understand their views and experiences in learning in science and the SBA.
4. Finally, intervention may be considered in longitudinal studies to investigate the changes in the quality of the SBA after teachers' professional development.

6.5 Final Reflection

With the current trends in the aims of science education, the roles of practical work and multiple purposes of educational assessment, science teachers' and curriculum development officers' views underlie the effectiveness of the purpose, design and implementation of SBA. This study has investigated a sample of these science educators' views and reported that there is a need for greater coherence in the aims of science teaching and the purpose, design and implementation of the science SBA for the SISC. This can be addressed by redefining the purpose, redesigning the SBA and continuously developing teachers' pedagogical content knowledge in science.

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APPENDICES

Appendix A – Science School Based Assessment for Solomon Islands School Certificate 2008-2009

1.0: *INTRODUCTION*

This is the new School Based Assessment (SBA), which forms 4 and 5 students in all secondary schools will undertake as part of their internal assessment in Science towards the national Solomon Islands School Certificate (SISC) examination. It is compulsory and must be completed before students sit the Solomon Islands School Certificate. Like past SBA, this SBA should begin in form 4 and be completed in form 5 the following year. This SBA is similar to the one compiled previously for year period (2007 to 2008) and strictly should be used for the year period 2008 to 2009 for forms 4 and 5 students in all secondary schools through out the country.

Your official and registered form four (F4) students this year should begin with this new School Based Assessment in 2008.

2.0: *AIM*

The overall aim of the School Based Assessment is to assess the skills necessary to science which are difficult to assess in the written examination. These are practical and research abilities and it includes the following performance skills;

1. Observations
2. Follow instructions to carry out an investigation with accuracy
3. record/collect and communicate data accurately
4. interpret data and respond correctly to questions related to the data and
5. draw valid conclusions

3.0: *TYPES OF ASSESSMENT*

This SBA is made up of two components. They are;

1. Pupil Performed Assessment Practical (PPAP)
    - 6 Common Assessment Practicals (CAP) and
    - 3 Teacher Design Assessment Practicals (TDAP)
2. Research Project
    - 1 research project per student

3.1: *Weighting for School Based Assessment (SBA)*

The SBA has a total weighting of 20%

- Practicals is awarded 15%
- Research Report 5%.

3.2: *Required Pupil Performed Assessment Practicals*

A total of 9 Practicals are required and are distributed as described from the following Strands or disciplines, 3 Biology, 3 Chemistry and 3 Physics and are set by the PCDO Science at the Curriculum Development Centre

- **6 Common Assessment Practicals (CAP)**

You are required to perform a total of 6 practicals, 2 Biology, 2 Chemistry, 2 Physics. It must be noted that, for each strand one topic must be from 4 and the other from form 5 (example, Biology – 1 x F4 and 1x F5 topic)

- **3 Teacher Designed Assessment Practicals (TDAP)**

You are required to design 3 Teacher Designed Assessment Practicals (TDAP) and it can be a form 4 or 5 topic and must be designed according to the standard format used in CAP. The TDAP must be distributed as 1Biology, 1Chemistry and 1Physics. Teachers are advised to prepare sample of the three practicals and indicate clearly in your programme schedule for official endorsement by the Science Advisory Committee (SAC).

- You are required to send in practical samples of your 3 TDAP for endorsement.
- The total marks for each TDAP is 30 marks (20 marks for practical and 10 marks for assessment of required skills)
- You will be notified (verbally/in writing) on any approval/changes of your TDAP before you are allowed to perform all your practicals with your students.

4.0: *BACKGROUND INFORMATION ON THIS NEW SCHOOL BASED ASSESSMENT*

4.1: *PUPILS PERFORMED ASSESSMENT PRACTICALS*

This new SBA is a revised version of the past SBA activities from collective views from workshop participants (June 2004) and consultative meetings by the Science Advisory Committee (SAC). There are few changes that are included in this new SBA.One of the major changes is on the pupil performed assessed practicals.

Unlike the past SBA, the new SBA is differ as each Science teacher is required to design three pupil performed assessment practicals to suit student needs and the availability of materials and equipment/apparatus at the school. In doing so the science teacher is required to draw up a SBA programmed schedule to realistically outline proposed dates for conducting each of the practicals.

The Program Schedule should include all practicals required (6 CAP and 3 TDAP).

You may include the following dates/weeks, form 4 or form 5 topic, type of practical and importantly materials & equipment/apparatus required for conducting the practicals.

Refer to Sample. You may include other useful information for the practicals.

Teachers are advised to return marked practicals to students only for consultation purposes and must be returned to the teacher for submission of completed samples for the final moderation at the end of the year. These practicals are conducted towards awarding of the final grade in the SISC. All practicals should be collected

back from students or should not be given to the students at all. Remember that all practicals are used for the form five SISC assessments nationwide.

This new SBA is trying to:

1. promote fairness and justice amongst students,
2. address the growing concerns that most schools do not have the basic consumables and equipment/apparatus at the secondary schools to conduct standard practicals set by the Secondary Science panel of the Ministry of Education & human resources development.
3. assist schools that do not have qualified Science teachers
4. assist schools that do not have appropriate science laboratories and
5. train students at form 4 and 5 level to acquire appropriate skills towards the same at form 6/7 level with the PSSC Internal Assessment Practicals and USP foundation studies.

This new SBA is prepared in consideration of the following:

1. Should be easy to organize and performed
2. Should not have excessive demand of materials and equipment/apparatus.
3. easy to be assessed
4. Involve use and application of process skills in a hands on situation (practical/experiment) and
5. Continuation at form 6 PSSC level, form 7 foundation and tertiary studies.

However in order to be consistent with the assessment, this office will provide SBA guidelines for science teachers selecting the required number of practicals and the standard marking criteria/scheme for both the pupil performed assessment practicals and the research projects.

5.0: *GUIDELINES FOR SELECTING PUPIL PERFORMED ASSESSMENT PRACTICALS (that are designed by teachers as TDAP)*

This handbook is designed purposely to assist science teachers with guidelines on how to plan and design appropriate practicals for their pupil performed assessment practicals that suit the needs of the students and the availability of equipment/apparatus and resources at the school.

As science resources and equipment/apparatus differ widely within our secondary schools, a provision is made to allow science teachers of all secondary schools to design its own pupil performed assessment practicals and be implemented under the TDAP component.

The TDAP must be distributed as 1Biology, 1Chemistry and 1Physics and it can be a form 4 or 5 topic obtained from the approved secondary science syllabus (1999 document) and will be designed by all form 4/5 science teachers through out the country.

The practicals must be properly documented in a programme schedule and must be submitted to the PCDO Science for endorsement by Science Advisory Committee (SAC) before you are allowed to perform all practicals (6 CAP and 3 TDAP) with your students.

All samples of your teacher designed assessment practicals (TDAP) must be submitted together with the SBA schedule.

The SBA programme schedule should reach PCDO Science (Curriculum Development Centre) by or not later than 30th April this year.

Science teachers are reminded to consider the following guidelines to assist them design the teacher design assessed practicals TDAS (student tasks) for School Based Assessment. These then can be included in the programme schedules for the year period 2008 to 2009.

1. Include practicals from forms 4 and 5 topics in the official secondary science syllabus for forms one to five.
2. The required 3 practicals must be distributed as 1 Biology, 1 Chemistry and

   1 Physics and should worth 30 marks each (20 marks from the practical and 10 marks from assessment of students skills as seen with the Common Assessed Practicals).
3. The combinations of the required practicals can be either; from form 4 topics and form 5 topics from the respective strands.
4. Include the date/week, forms 4 & 5 unit/topic, nature of practical and list of materials and equipment/apparatus. See attached sample
5. Summary of Pupils Performed Assessment Practicals and their weighting and
6. The time allocation for each practical be strictly 50 minutes duration.

5.1: *SCHOOL BASED ASSESSMENT (SBA) PROGRAMME SCHEDULE*

Teachers are expected to plan and construct practicals/investigations as required and should be tabulated in the suggested format shown below. This table should include all 9 practicals and the research topics to be assessed in the year period 2008 – 2009. Furthermore, you may indicate dates that you can realistically submit your completed research projects and student performed practicals.

For sample only

Week	**Date**	**Forms 4 or 5**	**Practical/ experiment**	**Material/ Equipment**	**Remarks**
1	14th March 2008	Form 4	Inheritance in Humans	Individuals Record sheet	
	5th July 2008	Form 4	Rates of reaction	Coral, HCl, Containers	
	30th Sept 2008	→			Allocate research topics to students
	6th April	Form 5	Is Oxygen necessary for photosynthesis	Plant, Containers (2),	

	2008			plastics (2) and soil etc	
	30th May 2009				Submission date for all research projects
	10th Aug 2009	Form 5	Gaseous exchange in Human beings	Bell Jar, Ballons Tubings, rubber bands	
	30th Aug 2009	→			Submission date for all practical reports

5.2: ***TEACHERS INFORMATION***

It is essential; however, that science teachers should bear in mind these practicals involves the teaching and learning processes. If science is to be learnt effectively, it must be experienced. Having said that practicals in this case are for assessment purposes, therefore the amount of assistance given by teachers during practicals must vary between students depending on the situations. It is worth bearing in mind that the assistance should be minimized to avoid practicals being assessed are of teachers work.

Science teachers are advised to be strict with the timing involved and to prepare well before a practical session is carried out. The teacher may pre-test the practical before your actual practical classes because it is not only for the teacher to have a sound idea of the unexpected results but also to avoid unnecessary and awkward situations while conducting the practicals.

The marking of the students practical and research projects must be done with professionalism and must be treated with high confidentiality to safe guard your credibility as a teacher and the purpose of the assessment for the students final science grade in the national Solomon Islands School Certificate (SISC) examination.

6.0: ***GUIDELINES FOR TEACHERS PREPARATION AN IMPLEMENTATION***

6.1: ***Administration and Organisation of Practicals.***

It is important for teachers to make advanced planning to ensure the implementation and completion of each practical. The following guidelines are provided to assist the teacher prepare well for the practicals.

- Ensure that the topic related to each practical has been adequately covered before students do each practical
- It is up to the teacher to decide how the practicals will be administered or organized. However, it is suggested that the teacher may need to set up the enough work stations for the students to allow sufficient space between students.

- Ensure that all materials and apparatus required for each practical is provided.
- Ensure that sufficient time is given for each practical
- The teacher must do each practical (before students do them) so that you can obtain your schools expected results. The results could be used as a reference to mark your students work.

6.2: ***Time allocation to conduct practicals***

The time allocation for students to do each practical is **strictly 50 minutes,** which is approximately the duration of one lesson/period taught in most secondary schools. Of the 50 minutes allocated, 5 minutes should be allowed for reading time.

It is important that instructions prepared by the teacher is clear and ensure that students read the instruction carefully before they start.

7.0: ***MARKING SCHEME***

A Standard marking criteria/scheme is provided to assist the teacher prepare his/her own marking scheme and allocation of marks based on the given skills to be assessed and the possible total marks to be awarded for each task/question in each practical. Use this guide to construct your own marking scheme.

The following skills will be assessed for all practicals (6 CAT and 3 TDAP)

- Ability to follow all instructions (2 marks)
- Ability to use apparatus correctly (2 marks)
- Ability to observe, record and analyze data (4 marks)
- Ability to draw scientific conclusions (2 marks)

The assessment of student skills should worth only **10 marks and 20 marks** for the Practical. Each practical should worth **30 marks only.**

8.0: ***STUDENT MARK BOOK***

You must construct your own mark book to record your student's scores. The mark book should be used to record your students score for forms 4 and 5. This means that you have to use this mark book for two years. Keep the mark book in a safe place so that you do not lose your records.

Teachers are advised to record their student practical marks in this format for the final marking and moderation of this new School Based Assessment.

Name	CAP						TDAP			Total 270 marks	% over 15%
	P 1 /30	P2 /30	P 3 /30	P4 /30	P5 /30	P6 /30	P7 /30	P8 /30	P9 /30		
1.											
2.											
3.											
4.											

It is advisable for all teachers to begin the practicals at the beginning of form 4 (2008) and to be completed in mid- year in form 5 the following year (2009)

1. ***COMMON ASSESSMENT PRACTICALS (CAP)***

- The following practicals are designed for assessment towards the form five (F5) SISC assessment or grades in 2009.
- Students are required to complete ONLY SIX (6) PRACTICALS.
- The required six practicals are distributed as follows; 2 x Biology, 2 x Chemistry and 2 x Physics. You are therefore required to study the following practicals and select any two practicals – where it says **or**, for Biology, Chemistry and Physics.
- The practicals identified for your students to perform must shown clearly in your School Based Assessment (SBA) program schedule. This must be submitted to PCDO Science at Curriculum Development Centre or Director NESU of the Ministry of Education and Human Resources Development

a) Biology
Practical 1: Inheritance in Humans **or**
Practical 2: Adaptation and Survival
Practical 3: Is Carbon dioxide produced in anaerobic respiration
or
Practical 4: Is Oxygen gas produced during photosynthesis

b) Chemistry
Practical 5: Rates of Reaction **or**
Practical 6: Test for the presence of Carbon dioxide Gas
Practical 7: Salts **or**
Practical 8: Displacement Reaction

c) Physics
Practical 9: Simple machines - Using Pulleys **or**
Practical 10: The Periscope Using light
Practical 11: Force and Movement **or**
Practical 12: The Collapsing Can

2. ***TEACHER DESIGNED ASSESSMENT PRACTICALS (TDAP)***

- The other three (3) practicals are teacher designed assessment practicals in which all Science teachers are encouraged to design according to the availability of resources and equipment at your school and as well as in compliance with the guidelines provided in this manual.
- Make sure the three practicals are based on form four and five topics in the official and approved Secondary Science Syllabus (1999 document).
- Make sure you prepare and submit samples of all TDAP and to clearly indicate them in the SBA Programme Schedule for official endorsement for the year period 2008 to 2009.
- Teacher Designed Assessed Practicals must be designed within in the approved format and should worth 30 marks each (20 marks for the practical and 10 marks for student skills).
- Please consult Science Advisory Committee or PCDO Science for assistance.

9.0: *RESEACH PROJECT*

The skills to be tested with the new SBA remain unchanged. However, there are few reminders for teachers to take note of for this new School Based Assessment for 2008 – 2009.

For transparency and accountability in the assessment of the new SBA, teachers are requested to submit **names of registered students in form four (F4) and their research topics** to the PCDO Science or Director NESU not later than **30th October 2008.**

Students should begin the research project in **form 4 (September/October**) and should be completed in **form 5 (end of April)** the following year. Subject teachers are advised to mark the research work completed by students and must be submitted together with the marks from the practicals by required due date.

9.1: *OBJECTIVES OF RESEARCH PROJECT*

The main objectives of research project are to allow students exhibit skills that they can use while in the school system and as well as applying the skills in other fields of work. The intended skills will cover the following areas.

- Collecting information from appropriate resources, including references
- Presentation of information
- Application of scientific knowledge
- Interpretation and understanding of data collected and
- Evaluation

9.2: *GUIDELINES FOR CONDUCTING A RESEARCH PROJECT*

9.2.1: *Selection of a research topic*

Students should be given the opportunity to undertake the research either on an issue about the topic they are studying or on another relevant topic (preferably an extension topic). Students are encouraged to use textbooks from the school library or may use other resource materials such as magazines, newspapers, radio and other resource materials that may be available.

Students are not expected to conduct a large research nor should they select a broad topic.

Students should rather a conduct a small scale research project, which can be narrowed down to a very small area of interest. The research project that students wish to undertake could be an experiment, a survey, or a review of an interesting topic.

The students should be given the opportunity to select their own topics from the given topics; however, it has to be confirmed by the science teacher (a list of all registered form 4 students with their topics) to the PCDO Science or Director NESU not later than **30th October 2008.**

All Secondary Science teachers involved are reminded to collect all student research projects on the final due date, marked and submission of student's research marks and the required samples must reach PCDO Science or Director NESU not later than **30th AUGUST 2009**.

Late submissions will not be considered for students final grading in the SISC Examination.

9.2.2: *Suggested Research Topics*

The Student could select a research topic from the following subject areas; Biology, Chemistry and Physics. Students must not select any new topic other than the topics provided in this manual.

Biology

- Genetic engineering – Its advantages and disadvantages
- A study of microbes
- Marine pollution – Causes and Effects in Solomon Islands
- Family planning practices/methods in Solomon Islands
- Traditional conservation practices/methods in your area

Chemistry

- Betel nut chewing – its chemistry and effects
- Re- cycling of used water – Its advantages and disadvantages
- Corals – Uses and its importance in Solomon Islands.
- Water Chlorination – its application, advantages and disadvantages

Physics

- Cyclones and earthquakes in Solomon Islands
- Recycling of aluminum metal – Is advantages and disadvantages
- The Weather and Climate Change in the tourism industry in SI
- The Weather and Climate Change in the fishing and agricultural industry in SI
- The Green house effect – its effects to low lying islands in Solomon Islands

10.0: *SURVEY*

Conducting surveys is an important skill and one that is not too difficult if a few simpler instructions are followed. For example, a particular student may wish to investigate the malaria cases in their school for the first six months of 2008. Students may need to be advised that when a survey is be conducted a questionnaire should be prepared.

The following instructions may guide students who wish to conduct a survey on the selected topic.

- Plan how you are going to collect information required
- Write the questions. Questions that are short are favoured by most people. They are also easier to answer, collate and analyze.
- Before the questions arte used, have someone or the teacher to check them first.
- Construct only few questions (eg 10 – 15 Questions) and use it to interview a sample of people (eg 20 people)
- Analyze and interpret your data.

11.0: *RESEARCH REPORT*

Students may also be allowed to pursue a project through experimentation. For this, students may need to design their own experiments or use experiments from other sources (eg textbooks).

A research report should include;

- Title of investigation/Activity
- List of materials and apparatus
- Methods used to conduct the investigation/activity
- Literature review on the topic of investigation (2 – 3 paragraphs)
- Results
- Discussion (Including data presentation and analysis).
- Recommendations
- Conclusion

12.0: *LITERATURE REVIEW*

This refers to a review of a topic that has been investigated by a particular student. For example, AIDS. Students will need to find out on how much information has been written about the topic.

The student should summarize the review in 2 to 3 paragraphs in their report writing

Teachers will need to provide some kind of guidelines to students so that the review is more specific to the research topic. Refer to section 13 for details on how to write a report.

13.0: *WRITING A RESEARCH REPORT*

Teachers are reminded to provide students with clear guidelines on how to write a research report. You may use the following as suggested guidelines.

A research report should not be less than three (3) pages and should not exceed more than ten (10) pages.

A research report should have the following sub- headings

- ***Title***
- ***Introduction*** (description of aim, topic being pursued and method used to collect data and information
- ***Main Body*** (preferably **literature review** on the topic undertaken or compilation on major information about the topic. For this, you need to refer to textbooks and other resources or references.
- ***Discussion*** **(** Discussion on information collected and interpretation of information/data collected
- ***Conclusion*** (Summary on what the student has discovered or learnt**)**

When writing a research report, the students should be reminded of the

Following;

- Written reports need to be legible and with in the page limit suggested. Students may use a computer, word processor, or a type writer although this is not a requirement.
- Students are encouraged to be more concise in their writing.
- Do not great portion of notes/information from the textbooks. It much better to write the information's in your own words.
- Students should be warned that copying notes word by word from textbooks is not allowed. They be warned that cheating or plagiarism is not allowed in schools and is a academic offence
- Always include a bibliography. This is the list of references that students use in their research. There are many ways that students can write bibliographies.

You may use the suggested guidelines

- **Author** – Surname first, then initials
- **Title of book or Article** (if it is an article, give name of journal as well)
- **Publisher** (name of publishing company**), Place** (where the article or book is published**) and the date of Publication,** (if it is a journal, then give the journal number, volume and date). It is also useful to give the page references.

Example:

The correct bibliography entry for a book is;
Parks, D., Heinemann Science in context 3. Heinemann Educational Australia, Port Melbourne, 1992
The correct bibliography entry for a journal is;
Rode, F (2001). Primary science education in Solomon Islands in the Pacific Curriculum Network, Number 5, Volume 2, 2001, pages 5 – 8.

14. STUDENT RESEARCH MARK RECORD

Teachers are advised to keep a record of their student research marks in this format for the final marking and moderation of this new School Based Assessment.

Name	**Research topic**	**Total mark (Research) 30 marks**	**Total mark Oral Presentation 10 marks**	**Total marks 40 marks**	**% Out of 5%**
1. Joe B	Marijuana	15	5	20	2.5
2.					
3.					
4.					
5.					
6.					
7.					

14.0: *MARKING CRITERIA FOR RESEARCH PROJECTS*

A standard marking criteria is not provided as students' projects may vary from one school to another. For this reason, teachers are asked to design their own marking criteria based on the following guidelines to mark your students' projects.

- The research project should be marked out of 40 marks
- Marks should be awarded as follows:

CRITERIA	POSSIBLE MARK
Cover Page, Table of Content and Acknowledgement	**3**
Introduction • Concise opening introductory statement • Aim of project explained vividly • Method used to conduct project explained	**3**
Main Body of Project • Detailed description of topic • Logical, relevant and sufficient use of information or content • Pictures, graphs, diagrams (where appropriate) included to support explanation • Very logical explanation of scientific theory or principle • Evidence of data collection (where appropriate)	**15**
Discussion and Analyses • Link information gathered to logical explanation • Correct interpretation of data or information gathered • Use own ideas to discuss information/data	**5**
Conclusion/ Bibliography • Provide logical conclusion-what the student has achieved • Provide list of text books cited-that is references and information sources appropriately acknowledge.	**4**
Oral Presentation • Introduction • Use of voice • Clear explanation • Conclusion/Recommendation	**10**
	TOTAL MARK = 40

15.0: *Oral presentation of RESEARCH findings*

It is now agreed that the oral presentation of the research project is to be assessed in the period 2007 -2008. Therefore, oral presentation of research report should be organized for students conducting the research to make a formal presentation on his/her research.

The oral presentation by students should be organized for 10 – 20 minutes duration.

The mark allocation for the oral presentation is now included in the marking criteria/scheme.

16.0: *PENALTIES FOR CHEATING*

Cheating or copying some ones work other than your own is a serious crime.

Teachers are advised to inform students that penalties such as deduction of marks can be **imposed on students who have proved to commit cheating or copying some ones work other that their own in the research project.**

17.0: *SCHOOL BASED ASSESSMENT RESULT*

You should post or deliver your students' SBA Results to the *Director of National Examination and Standard Unit*. The SBA results should reach the Director of NESU on the specific due dates before the students sit the SISC Examination. The address is:

Director

National Examination and Standard Unit

Ministry of Education and Training

PO Box G28, Honiara

Your students' SBA results must be accompanied with the following documents and must reach the above address by or not later than 30th of August in that examination year **(30th August 2009).**

RESEARCH PROJECT

- Marking scheme for the research report (1)
- A brief report on the research project.
- Sample of students' research reports (5 best & 5 below average)
- Students Research mark sheet

PUPIL PERFORMED ASSESSMENT PRACTICALS

- A marking scheme used to mark each Practical (9)
- Sample of students' practicals (5 best & 5 below average)
- A Brief report on the practicals
- Students practicals mark sheet

Any late submission would not be considered for final grading in the SISC Examinations.

Appendix B – Samples of Practical Assessment Activities in SBA for the SISC

A. BIOLOGY COMPONENT

Investigation 1

Practical 1 - Inheritance in Humans

Background notes

Genetics is a study of genetic inheritance in which certain traits/characteristics are transferred from parents to offsprings. Usually such inheritance of characteristics are influenced by genetic information with in nucleus of cells and also environmental influences .However, it is generally accepted that expressions of certain characteristics in offsprings is due to coding pairs of both dominant and recessive alleles.

The phenotypes (expressed characteristics) in humans are dependant on presence of dominant alleles and are observable. Usually dominant alleles masked recessive alleles. Traits due to recessive alleles often disappear for one or more generations unless dominant alleles are not present.

In this practical, you are going to observe certain traits and characteristics that are commonly inherited in humans. Refer to table 1

Table 1: Inherited human traits and characteristics.

Dominant	
1.Curly hair	1.Straight hair
2.Free hanging ear lobes	2.Attached ear lobes
3.Second toe shorter than first	3. Second toe longer than first
4.Ability to roll tongue	4. Inability to roll tongue
5.Right hand ness	5. Left hand ness

1.2: Materials

1. Biro
2. Individuals
3. Report sheet

1.3: Procedures

1. Allocate students in to groups of individuals.
2. Study (investigate) the phenotypic trait in table 1 and observe the characteristics against each Individuals
3. Record your results in the table in the report sheet provided.
4. Answer the following questions based on your results

Report Sheet for Investigation 1

Practical 1: Inheritance in Humans

1. **Aim.**

_____
_____
_____

(1 mark)

2. **Brief Description** (Write a brief discussion of what you did)

_____
_____
_____

(2 marks)

3. **Results**

	Characteristics/Traits					
Students	M/F	Curly/Straight hair	Free/attached Ear lobe	Second toe longer/shorter than first one	Ability/ Inability To roll tongue	Right/left Handness
1						
2						
3						
4						
5						

(5 marks)

5. **Questions**

Answer the following questions

a) Which characteristics are dominant in all five individuals and explain Why?

(2 marks)

b) Determine what characteristic is recessive and explain it is recessive in that particular individual?

(2marks)

c) Explain why the following characteristics you have observed/studied appeared for the individuals

---

(2marks)

d) What are your comments on the similarity and differences amongst the individuals studied in your group?

(2 marks)

6. Write a brief conclusion for this activity

(2marks)

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Assessment of student skills

Skills	Marks/Possible Mark
1. Ability to follow instructions	/2
2. Ability to collect, record, calculate and analyze data	/4
3. Ability to use equipment correctly	/2
4. Ability to draw appropriate conclusions	/2
TOTAL MARKS	**/10**

Total Marks for Practical 1: Inheritance in Humans

Marks for practical 1	/20
Marks for student skills	/10
TOTAL MARKS FOR PRACTICAL 1	**/30**

INVESTIGATION 5

B. CHEMISTRY COMPONENT

Practical 5: Rates of Reactions

Background information

Chemical reactions happen everyday everywhere inside us and around us. Some of these reactions are fast and some are slow. How fast or slow chemical reactions occur is called *RATE OF REACTION.* Rate of reactions is affected by many factors which include the following;

- Concentration
- Temperature
- Surface Area
- Catalyst

In this activity students are to investigate one of the factors that affect rate of reaction. The factor to be investigated is surface area. It is inferred that reacting particles with large surface areas will react more faster than reacting particles with small surface areas.

3.2: Aim:

This activity aims at achieving two important things. First is to investigate the rate of reaction between Calcium Carbonate (Coral) of two different sizes (crushed and lump) and Hydrochloric acid or Citric acid (lemon juice). Secondly is to enable students to make meaningful scientific observations and critically analyze them.

3.3: Materials and Apparatus

1. Test tubes or Schweppes bottles, test tube racks, wash bottles wrist watches
2. Chemicals: O.1 ml hydrochloric acid (HCl) or Lemon juice. Calcium Carbonate or coral (finely grounded or crushed and lump)

3.4: Procedures

1. In a clean test tube or Schweppes bottle add one spatula or teaspoon of powdered Calcium carbonate or Coral.
2. In another test tube or Schweppes bottle repeat procedure (1) using lumps of Calcium carbonate or Coral.
3. Use a 30cm ruler to measure from the bottom of the test tube or Schweppes bottle in procedure (1) and add about 2cm of 0.1M HCl or lemon juice and measure the time taken for the reaction to settle.
4. Repeat procedure (3) in the test tube or Schweppes bottle in procedure (2).
5. Record all observations in the result table in the student answer sheet

1. Preparation of lemon juice

- Collect one lemon and squeeze juice in to a 300 ml Schweppes bottle
- Fill bottle with water to the neck
- Bore a small hole on top of the lid of the bottle and is ready for use

Practical 5: Rate of Reaction

REPORT SHEET FOR INVESTIGATION 5

Aim

(1 mark)

Brief Description (Write a brief discussion of what you did)

(2 marks)

Results

Type of Reagent (Acids)	Size of Calcium Carbonate(Coral)	Time taken for reaction to settle	Observations

(4 marks)

Questions

1. How would you tell that a chemical reaction has taken place? Give a reason for your answer.

(2 marks)

2. Compare the two mixtures and comment on the time taken for the mixtures to settle?

(1 marks)

3. Compare the rate of reaction between the two mixtures. Give reasons for your answer.

(3 marks)

4. What is the relationship between the surface area and the rate of reactions?

(3 marks)

5. Write a brief conclusion for this activity?

(3 marks)

FOR OFFICIAL USE ONLY

Assessment of student skills

Skills	Marks/Possible Mark
1. Ability to follow instructions	/2
2. Ability to collect, record calculate and analyze data	/4
3. Ability to use equipment correctly	/1
4. Ability to draw appropriate conclusions	/3
TOTAL MARKS	**/10**

Total Marks for Practical 5: Rates of Reaction

Marks for practical 5	/20
Marks for student skills	/10
TOTAL MARKS FOR PRACTICAL 5	**/30**

C: PHYSICS COMPONENT

INVESTIGATION 9

SIMPLE MACHINES

Practical 9: **Using Pulleys**

Background

Machines are often used to magnify the force or effort that we supply. The mechanical advantage (MA) of a machine tells us how much the force is magnified. Pulleys are devices we used to give us a mechanical advantage, and they help us to lift objects that would normally be too heavy. To operate a pulley system, one uses effort to pull on the rope. The rope slides on the pulley, turning the wheel and the load is lifted.

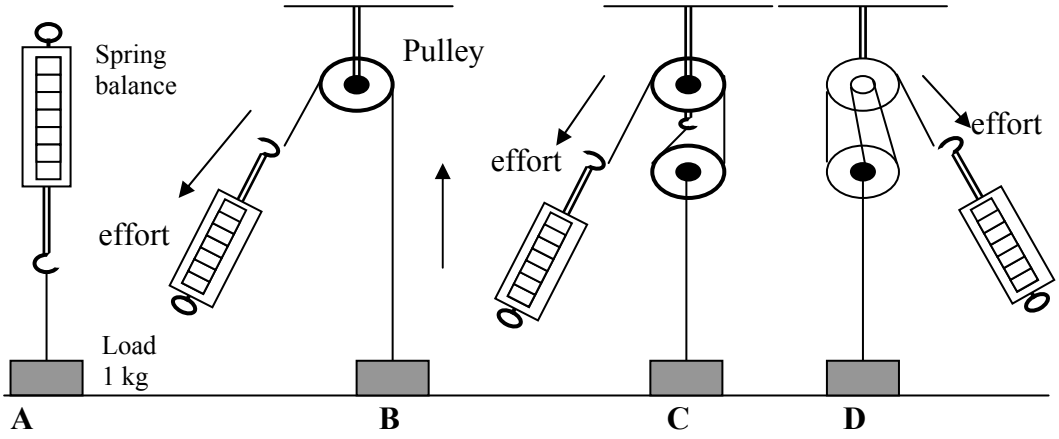
To measure forces we use a spring balance. Force is usually measured in newtons (N). If your spring balance is graduated in grams or kilograms, use the following approximation conversion:

1 Kg = 10 N and 100 g = 1 N

Materials required:

One 1Kg mass, Pulleys, Spring balance, Trolley, Inclined plane.

1. Set up each of the following systems. In each case you will be lifting a 1 Kg mass vertically off a bench. You have to measure the effort required to this by using the spring balance. Do the experiments in the order shown.



2. Complete the following table of results.

Experiment	Load (in newtons)	Effort (in newtons)	MA = load / effort
a. No pulley			
b. One pulley			
c. Two pulleys			
d. Three pulleys			

Calculations and Analysis of Data

3. What does MA stands for? …….....

4. Which experiment requires the greatest effort? Why do you think this was? …….
……..
5. Which experiment requires the least effort? Why do you think this was?
……
…..……
6. As the number of pulleys increased, what happened to;
a). the effort? ……..
b). the MA? ……
7. Give two examples of everyday situations were pulleys are used to lift loads.
1. ……...
2. ……...

B The incline plane

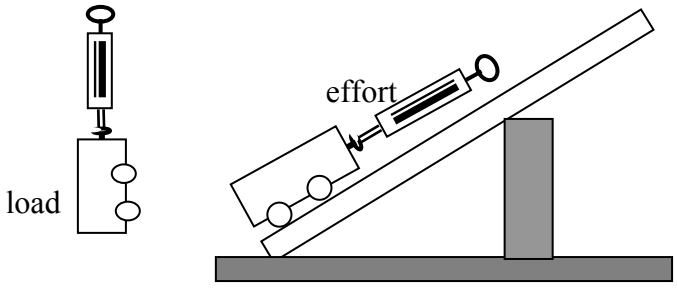
A ramp, a slope and a hill are examples of inclined planes. We often use ramps to lift heavy loads up a height.

8. Use a spring balance to measure the force required to lift a small trolley vertically.

   Force required = Load = …… N

9. Measure the effort required to pull the same trolley up an incline plane.

   Effort required = …… N



10. Is the effort smaller than the load? ……
……

11. What is the mechanical advantage (MA) of the plane?

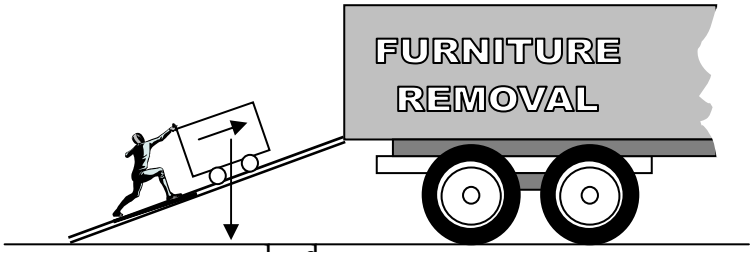
    MA = load / effort = ……

12. Why do you think the ancient Egyptian used inclined planes to build pyramids?
……..
……..

13. Why do people (eg furniture removalists) use ramps to move goods into their vans?

…….....

……..



Practical 9: Simple Machines
Aim:

REPORT SHHET FOR INVESTIGATION 9

_____
_____
_____
_____

(1 mark)

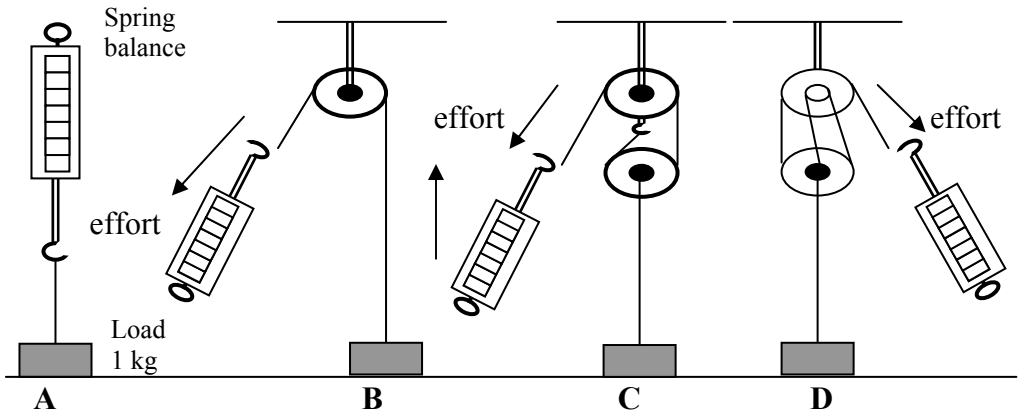
A Brief Description (Write a brief discussion on what you did)

_____
_____
_____
_____
_____

(2 mark)

Results

Set up each of the following systems. In each case you will be lifting a 1 Kg mass vertically off a bench. You have to measure the effort required to this by using the spring balance. Do the experiments in the order shown.



2. Complete the following table of results.

Experiment	Load (in newtons)	Effort (in newtons)	MA = load / effort
a. No pulley			
b. One pulley			
c. Two pulleys			
d. Three pulleys			

(4 marks)

Calculations and Analysis of Data

3. What does MA stands for? …….....

(1 mark)

4. Which experiment requires the greatest effort? Why do you think this was?

…….....

(1 mark)

5. Which experiment requires the least effort? Why do you think this was?
……..
……
(1 marks)

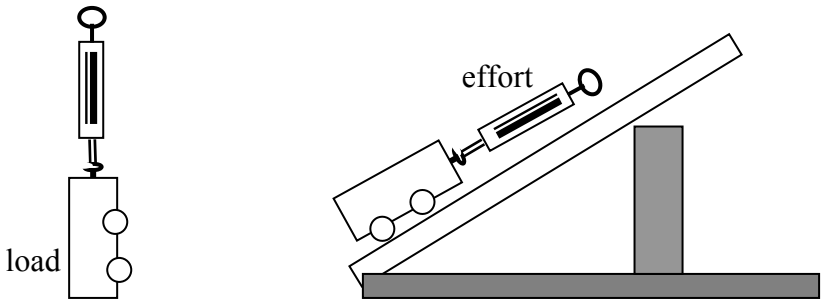
6. As the number of pulleys increased, what happened to:
a) the effort? ……
b). the MA? …….
(1 marks)

7. Give two examples of everyday situations were pulleys are used to lift loads.
1. ……
2. ……
(1 marks)

B The incline plane

A ramp, a slope and a hill are examples of inclined planes. We often use ramps to lift heavy loads up a height.

8. Use a spring balance to measure the force required to lift a small trolley vertically.
Force required = Load = …… N (1 mark)
9. Measure the effort required to pull the same trolley up an incline plane.
Effort required = ……N (1 mark)

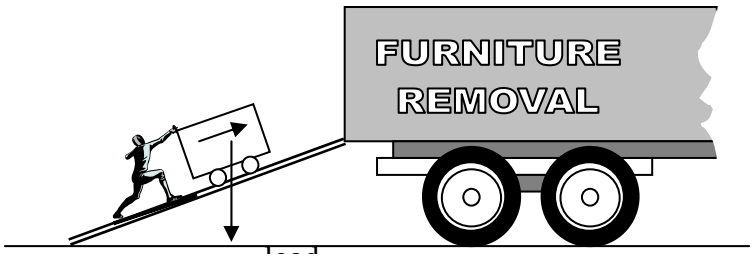


10. Is the effort smaller than the load? ……
……
(1 mark)

11. What is the mechanical advantage (MA) of the plane?
MA = load / effort = …… (1 mark)

12. Why do you think the ancient Egyptian used inclined planes to build pyramids?
……
……
…… (1 mark)

13. Why do people (eg furniture removalists) use ramps to move goods into their vans?
……
……



(1 mark)

14. Write a conclusion for this activity?

(2 marks)

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Assessment of student skills

Skills	Marks/Possible Mark
1. Ability to follow instructions	/2
2. Ability to collect, record, calculate and analyze data	/4
3. Ability to use equipment correctly	/1
4. Ability to draw appropriate conclusions	/3
TOTAL MARKS	**/10**

Total Marks for Practical 9: Simple machines – Using Pulleys

Marks for practical 9	/20
Marks for student skills	/10
TOTAL MARKS FOR PRACTICAL 9	**/30**

Appendix C – Letter to the Ministry of Education

CHAIRPERSON
Research Committee
Ministry of Education and Human Resources Development
P. O. Box G28,
Honiara,
Solomon Islands.

Dear Sir/Madam

Re: A Letter to Inform and to Seek Permission to Undertake Research in Honiara Solomon Islands

I am currently undertaking a research project as partial requirement for the completion of a Master of Education degree at the University of Waikato. My research intends to involve seven form 4 and 5 science teacher participants from four secondary schools in Honiara and a science curriculum development officer from the Curriculum Development Centre. As such, to conduct my research, I need your kind assistance.

I humbly request permission from your good office on behalf of the Solomon Islands Government and the Ministry of Education to conduct my research involving participants from four secondary schools and the Curriculum Development Centre in Honiara, Solomon Islands.

Moreover, this letter also serves to inform you that all the data generated from the participants will be used solely for research purposes and treated confidentially such that anonymity of all participants and the schools will be maximized.

I have attached my research design proposal which contain the research goals, objectives, significance and the methodology.

If you have any questions or queries about the research please do not hesitate to contact me.

I trust that you will kindly grant me the permission to conduct my research.

Thank you and I appreciate your consideration in anticipation.

Yours in Education

Lionel Kakai

Email: lionel.kakai@gmail.com

Appendix D – Principal Information Pack

D.1 Letter Seeking Permission from Principals

PRINCIPAL
.....School
P. O. Box.....
Honiara
Solomon Islands

Dear Sir/Madam

Re: Letter Seeking Your Permission and Assistance to Undertake Research

I am currently completing research as partial requirement for a Master of Education degree at the University of Waikato. The research intends to involve seven form 4 and 5 science teachers and a science curriculum development officer. Two science teacher participants in form 4 and 5 will be invited from each of the four secondary schools.

As such, I kindly request permission from your good office to conduct the research involving the participants from your School. This research aims to explore and develop better understanding from the views of the teacher participants about the purpose, designs and implementation of science practical assessment activities in the School Based Assessment (SBA) for Solomon Islands School Certificate (SISC).

For the worthy cause, I humbly seek your assistance to invite on voluntary basis, most preferably, one form 4 and one form 5 science teacher who participates in conducting the science practical assessment activities in the Science SBA for SISC.

I have attached a Principal information sheet and copies of teachers' letter, teacher participants' information sheets and informed consent forms which you will give to each invited teacher participant.

If you have any questions or queries about the research, please do not hesitate to contact me.

I trust that you will kindly grant me the permission to conduct the research in your school.

Thank you and I greatly appreciate your assistance in advance.

Yours in Education

Lionel Kakai

Email: lionel.kakai@gmail.com

D.2 Information Sheet for Principals

Project Title

Science Practical Assessment Activities in School Based Assessment: An interpretive study on the perceptions of one Science Curriculum Development Officer and seven Science Teachers in Honiara, Solomon Islands.

Purpose

This research is conducted as partial requirement for a Master of Education degree. This research requires me as the researcher to choose a topic and conduct research on the topic through using individual interview method for all participants.

What is this research project about?

This research aims to explore and develop better understanding from the views of seven science teachers about the purpose, designs and implementation of science practical assessment activities in the School Based Assessment (SBA) for Solomon Islands School Certificate (SISC). Significantly, the implications from this research will enhance better understanding that will influence the ongoing development of the assessment strategies in secondary science curriculum specifically in the design and implementation of science practical assessment activities in the SBA for SISC.

What will you have to do and how long will it take?

On voluntary basis I want to involve two teachers from your school. I want to interview the teacher participants on individual basis at a place and time convenient to each teacher which will not disturb their classes. The interview may be audio recorded and the teachers will be asked to give consent prior to the interview, and maybe asked to also give consent at a later stage when appropriate. The interview will be transcribed and the transcript will be air mailed to each respective teacher for verification at a later stage.

What will happen to the data collected?

The data generated will be used by me to write a thesis for the credit of a Master of Education degree. It is possible that articles and presentations may be the outcome of the research. My supervisor and I will be privy to the data and documents gathered. I will keep transcripts of recordings and copies of documents and written paper but will treat them with the strictest confidentiality. Every effort will be made to maximize the anonymity of teachers and the school. No participant will be named in any publication and/or report.

Who's responsible?

If you have any questions or concerns about the research, either now or in the future, please feel free to contact either:

Researcher
Lionel Kakai,
CSTER,
The University of Waikato,
Private Bag 3105,
Hamilton, New Zealand
Email: lionel.kakai@gmail.com

Supervisor
Associate Professor Beverly Bell,
School of Education,
The University of Waikato,
Private Bag 3105,
Hamilton, New Zealand,
Email: beebell@waikato.ac.nz

Appendix E – Curriculum Development Officer Information Pack

E.1 Letter Inviting Curriculum Officer

Principal Curriculum Development Officer Science
Curriculum Development Centre
Honiara
Solomon Islands

Dear Sir/Madam

Re: Letter to Inform and to Invite You as a Curriculum Officer Participant

I am currently completing research as partial requirement for a Master of Education degree at the University of Waikato. The research intends to involve in particular a secondary science curriculum development officer along with seven form 4 and 5 science teachers from four secondary schools in Honiara who are familiar with the science practical assessment activities in the School Based Assessment (SBA) for Solomon Islands School Certificate (SISC).

This letter is to inform you that you have been invited on voluntary basis to participate in the research. This research aims to explore and develop better understanding from your view as a science curriculum development officer about the purpose, the designs and the implementation of science practical assessment activities in the SBA for SISC.

Please read the curriculum officer participant's information sheet and informed consent form I have attached. I will ensure that you understand the nature of your involvement and you are happy with it before you complete the Informed consent form.

If you have any questions or queries about the research please do not hesitate to contact me.

Thank you and I greatly appreciate your participation in advance.

Yours in Education

Lionel Kakai

Email: lionel.kakai@gmail.com

E.2 Information Sheet for Curriculum Officer

Project Title

Science Practical Assessment Activities in School Based Assessment: An interpretive study on the perceptions of one Science Curriculum Development Officer and seven Science Teachers in Honiara, Solomon Islands.

Purpose

This research is conducted as partial requirement for a Master of Education degree. This research requires me as the researcher to choose a topic and conduct a research on the topic through using individual interview method for **Curriculum Officer Participant**.

What is this research project about?

This research aims to explore and develop better understanding from your view as a science curriculum development officer about the purposes, designs and implementation of science practical assessment activities in the School Based Assessment (SBA) for Solomon Islands School Certificate (SISC). Significantly, the implications from this research will enhance better understanding that will influence the ongoing development of the assessment strategies in secondary science curriculum specifically in the issues pertaining to the design and implementation of science practical assessment activities in the SBA for SISC.

What will you have to do and how long will it take?

On voluntary basis I will want to interview you on individual basis at a place and time convenient to you. The individual interview should take no longer than 40 minutes. I may ask you for relevant documents, relating to assessment activities specifically for illustration purposes. The interview will be audio recorded and you will be asked to give consent prior to the interview, and maybe asked to also give consent at a later stage when appropriate. The recorded interview will be transcribed and the transcript will be air mailed to you for verification at a later stage. Whatever data generated from you that will be used either directly or indirectly requires your consent and approval at later stages as well, when appropriate, because maximizing your anonymity is not guaranteed due to the nature of your position.

What will happen to the data collected?

I will use the data generated to write a thesis for the credit of a Master of Education degree. It is possible that articles and presentations may be the outcome of the research. My supervisor and I will be privy to the data and documents gathered. I will keep transcripts of recordings and copies of documents and written paper but will treat them with the strictest confidentiality.

Declaration to participants

If you take part in this research, you have the right to:

- Refuse to answer any particular question, withdraw from participation and/or withhold any data you provide at any time up until one week after you confirm and verify your transcripts.
- Ask any further questions about the research that occurs to you during your participation.

- Be given access to the completed thesis via appropriate institutions and websites.

Who's responsible?

If you have any questions or concerns about the research, either now or in the future, please feel free to contact either:

Researcher
Lionel Kakai,
The University of Waikato,
Private Bag 3105,
Hamilton, New Zealand
Email: lionel.kakai@gmail.com

Supervisor
Associate Professor Beverly Bell,
School of Education
The University of Waikato,
Private Bag 3105,
Hamilton, New Zealand,
Email: beebell@waikato.ac.nz

E.3 Informed Consent Form for Curriculum Officer

Consent Form for Science Curriculum Officer Participant (*Please circle*)

I have read the **Curriculum Officer Participant Information Sheet** for this study and have had the details of the study explained to me. My questions about the study have been answered to my satisfaction, and I understand that I may ask further questions at any time.	**YES NO**
I also understand that I am free to withdraw from the study at any time up until one week after I have verified and confirmed my transcripts.	**YES NO**
I understand that I am free to decline to answer any particular questions in the interview.	**YES NO**
I understand I can withdraw any information I have provided up until after I have verified and confirmed my transcripts.	**YES NO**
I agree to provide information to the researcher under the conditions of confidentiality set out on the **Curriculum Officer Participant Information Sheet**.	**YES NO**
I agree to participate in this research under the conditions set out in the **Curriculum Officer Participant Information Sheet.**	**YES NO**

Full Name: (*Please Print*).....
(*First Name*) (*Last Name*)

Signed: .....Date: .....

.....

Additional Consent as Required

(*Please Tick*)

I agree☐ / do not agree ☐ to my responses being tape recorded in the interviews.

I agree☐ / do not agree ☐ to my documents being used for illustrations in the study.

Full Name: (*Please Print*).....
(*First Name*) (*Last Name*)

Signed: .....Date: .....

Appendix F – Teacher Information Pack

F.1 Letter Inviting Teachers

Dear Sir/Madam

Re: Letter to Inform and to Invite You as a Teacher Participant

I am currently completing research as partial requirement for a Master of Education degree at the University of Waikato. The research intends to involve in particular seven form 4 and 5 science teachers along with one science curriculum development officer who are familiar with the science practical assessment activities in the School Based Assessment (SBA) for Solomon Islands School Certificate (SISC).

This letter is to inform you that you have been invited on voluntary basis to participate in the research. This research aims to explore and develop better understanding from your view as a science teacher about the purpose, designs and implementation of science practical assessment activities in the SBA for SISC.

Please read the teacher participants' information sheet and informed consent form I have attached. I will ensure that you understand the nature of your involvement and you are happy with it before you complete the Informed consent form.

If you have any questions or queries about the research, please do not hesitate to contact me.

Thank you and I greatly appreciate your participation in advance.

Yours in Education

Lionel Kakai

Email: lionel.kakai@gmail.com

F.2 Information Sheet for Teacher Participants

Project Title

Science Practical Assessment Activities in School Based Assessment: An interpretive study on the perceptions of one Science Curriculum Development Officer and seven Science Teachers in Honiara, Solomon Islands.

Purpose

This research is conducted as partial requirement for a Master of Education degree. This research requires the researcher to choose a topic and conduct research using individual interview methods for **Teacher Participants**.

What is this research project about?

This research aims to explore and develop better understanding from your view as science teachers about the purpose, design and implementation of science practical assessment activities in the School Based Assessment (SBA) for Solomon Islands School Certificate (SISC). Significantly, the implications from this research will enhance better understanding that will influence the ongoing development of the assessment strategies in secondary science curriculum specifically in the design and implementation of science practical assessment activities in the SBA for SISC.

What will you have to do and how long will it take?

On voluntary basis I want to interview you on individual basis at a place and time convenient to you. The individual interviews should take no longer than 40 minutes. I may ask for relevant documents, such as a copy of your designed assessment activities specifically for illustration purposes. The interview may be audio recorded and you will be asked to give consent prior to the interview, and maybe asked to also give consent at a later stage when appropriate. The interview will be transcribed and the transcript will be air mailed to you for verification at a later stage.

What will happen to the data collected?

I will use the data generated to write a thesis for the credit of a Master of Education degree. It is possible that articles and presentations may be the outcome of the research. My supervisor and I will be privy to the data and documents gathered. I will keep transcripts of recordings and copies of documents and written paper but will treat them with the strictest confidentiality. Every effort will be made to maximize the anonymity of teachers and no teacher participant will be named in any publication and/or report. I will select pseudonyms to be used instead.

Declaration to participants

If you take part in this research, you have the right to:

- Refuse to answer any particular question, withdraw from participation and/or withhold any data you provide at any time up until one week after the focus group interview or after you confirm and verify your transcripts, which ever is later.
- Ask any further questions about the research that occurs to you during your participation.

- Be given access to the completed thesis via appropriate institutions and websites.

Who's responsible?

If you have any questions or concerns about the research, either now or in the future, please feel free to contact either:

Researcher
Lionel Kakai,
CSTER,
The University of Waikato,
Private Bag 3105,
Hamilton, New Zealand
Email: lionel.kakai@gmail.com

Supervisor
Associate Professor Beverly Bell,
School of Education,
The University of Waikato,
Private Bag 3105,
Hamilton, New Zealand,
Email: beebell@waikato.ac.nz

F.3 Informed Consent Form for Teacher Participants

Consent Form for Teacher Participants

	(*Please circle*)
I have read the **Teacher Participant Information Sheet** for this study and have had the details of the study explained to me. My questions about the study have been answered to my satisfaction, and I understand that I may ask further questions at any time.	**YES NO**
I also understand that I am free to withdraw from the study at any time up to one week after the focus group interview or after I have verified and confirmed my transcripts, which ever is the later.	**YES NO**
I understand that I am free to decline to answer any particular questions in the interview.	**YES NO**
I understand I can withdraw any information I have provided up until after I have verified and confirmed my transcripts.	**YES NO**
I agree to provide information to the researcher under the conditions of confidentiality set out on the **Teacher Participant Information Sheet**.	**YES NO**
I agree to participate in this research under the conditions set out in the **Teacher Participant Information Sheet.**	**YES NO**

Full Name: (*Please Print*).....
(*First Name*) (*Last Name*)

Signed: ..... Date: .....

.....

Additional Consent as Required

(*Please Tick*)

I agree☐ /do not agree☐ to my responses to be tape recorded in the interviews and as part of the focus group interview.

I agree☐ /do not agree☐ to my documents being used for illustrations in the study.

Full Name: (*Please Print*).....
(*First Name*) (*Last Name*)

Signed: ..... Date: .....

Appendix G – Teacher Interview Schedule

Main Interview Questions

Introductory chatting will involve gathering a brief background of the teacher participant. This will include the following specific questions:

i. *How long have you been teaching science in high school?*
ii. *How long have you been involved in designing and conducting SBA activities?*
iii. *Where did you have your pre-service teaching education?*

.....

0. (Introductory question) Can you tell me about the way you teach science?
1. What do you think is the main aim of teaching science?
   (1b) What would be the main things you would like students to learn in your science classroom?
2. What are your views about the role of practical work in teaching and learning science?
   (2b) What do you think are the learning outcomes of practical work in science?
   (2c) What do you understand about the ways scientists work or scientific methods?
3. What are your views about the practical assessment activities in the SBA for SISC?
4. What do you think about the assessment schedules given in the SBA for SISC?
5. Can you talk about how you see the SBA activities assessing the science learnt by the students?
6. What sort of concerns do you have about the practical work and its assessment in the SBA for form 4 and form 5?
7. Can you talk about how best you would use practical work to assess students learning in science?
8. What changes would you like to see in the practical work in the SBA for SISC?

Appendix H – Curriculum Officer Interview Schedule

Main Interview Questions

Introductory chatting will involve gathering brief background information. This will include the following specific questions:

i. *How long have you been teaching science in high school?*
ii. *How long have you been involved in designing and conducting SBA activities?*
iii. *Where did you have your pre-service teaching education?*

.....

0. (Introductory question) Can you tell me about the way you view science as a core subject?
1. What do you think is the main aim of teaching science?

   (1b) What would be the main things you would like students to learn in science classroom?
2. What are your views about the role of practical work in teaching and learning science?

   (2b) What do you think are the learning outcomes of practical work in science?

   (2c) What do you understand about the ways scientists work or scientific methods?
3. What are your views about the practical assessment activities in the SBA for SISC?
4. What do you think about the assessment schedules given in the SBA for SISC?
5. Can you talk about how you see the SBA activities assessing the science learnt by the students?
6. What sort of concerns do you have about the practical work and its assessment in the SBA for form 4 and form 5?
7. Can you talk about how best you would use practical work to assess students learning in science?
8. What changes would you like to see in the practical work in the SBA for SISC?