Exploring the role that language plays in solving mathematical word problems for the Solomon Islands secondary school students

by

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ABSTRACT

Mathematics is described as language. There is a strong link between mathematics and English language. This study is concerned with the role of language factors and proficiency of students in comprehension and solving of word problems in the Solomon Islands. In particular, it explores the impact of language on the comprehension and solving of word problems for year eight students in three secondary schools in Honiara.

Research data was gathered using mixed-method approach of data collection. The data collection happened in two phases. Firstly language and mathematical assessment portfolios were put together for 45 participants. Secondly, a semi-structured recall interview was conducted on eight participants chosen from the 45. The data gathering was conducted in the Solomon Islands in September 2009.

There are interesting findings revealed in this research. In the language and mathematics baseline assessment portfolios, the scatter diagram showed no strong correlation between vocabulary knowledge and word problem solving. However, evidence from the word problems exercise and semi-structured recall interview elicited vocabulary and syntactical features as the main factors causing difficulties in word problems solving for the secondary school of the Solomon Islands students. Context and conceptual understanding played a role in facilitating the understanding of word problems. Some students demonstrated abilities contributing to their achievement in mathematics and language. However, further studies need to be done in relation to this area as it is very important and has implications for pedagogy, curriculum and learning improvement for teachers and students.

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CHAPTER 0NE: INTRODUCTION

1.0 Setting the scene

The Solomon Islands gained independence from Great Britain in 1978. After being left by the British, the Solomon Islands still adopt English as the official language. This language is compulsory in education. In classrooms for example, all lessons are officially taught in English.

However, not all Solomon Islanders are first language speakers of English. There are about eighty vernacular languages spoken in the Solomon Islands (Wasuka, 2006). Within the boundaries of the major languages, there are different dialects. The majority of the population do speak English as their second or third language. The limited English language background of Solomon Islanders influences mathematics learning which, like other subjects is taught in English.

1.1 Rationale

There is a link between English language proficiency and mathematics learning. I feel that there is a need for the Solomon Islands mathematics and English teachers to recognise this link. Limited English language knowledge hinders students' learning and understanding of mathematics. There is a gap in the area of solving mathematical word problems. This is due to the difficulty of comprehending the language used in the writing of the word problems. There is a potential vocabulary problem that creates difficulty in understanding mathematical concepts (Thompson & Rubenstein, 2007). As a former mathematics teacher in the Solomon Islands, I feel there is a need to work on improving this language and mathematics gap.

I wanted to explore mathematical word problems. Since mathematical word problems are written in and learnt in English, it is my desire to explore the difficulties associated with comprehension and solving of mathematical word problems expressed in English. The difficulties that I wish to explore are related to linguistic features like the syntactic features and mathematical vocabulary which may affect the comprehension of word problems.

It is hoped that findings of this research might be important for teaching and future research in mathematics in the Solomon Islands. In teaching it is necessary to find out the appropriate teaching strategies to address the language gap associated with mathematical word problem solving, although this does not fall within the scope of the thesis.

1.2 Interest in language and mathematical word problems

According to Jitendra (2008), improving the problem solving skills of students has been a great challenge in United States schools. The challenge is far greater in the Solomon Islands which is largely a non-English speaking country. In the Solomon Islands, mathematics is a very important subject as far as the National Curriculum is concerned. However, there are a number of problems in mathematics. These problems are perhaps created by the difficulty in comprehension of English language, more so when it is used to teach mathematics. Language in mathematics is very important as it involves areas pertaining to thinking, writing, speaking and comprehension (Thompson & Rubeinstein, 2000).

This area of inquiry is based on the fact that mathematics is claimed to be a language and is foreign (Usiskin, 1996) for most students of the Solomon Islands. Mathematics has a highly specialized structure, technical and highly specialized vocabulary and symbolic notation (Bullock, 1994; Schleppegrell, 2007). Furthermore, word problems seem to contain certain complex features. These characteristics are presumed to be the causes of difficulties in the understanding and solving of word problems for a Solomon Islands student. This has motivated my desire to do studies in mathematics and language. To date, studies have been done in various non-English speaking countries (Abedi & Lord, 2001; Bernardo, 2002, 2005, Garegae, 2007) but little is being done in a Melanesian country like the Solomon Islands.

I am interested in linguistic areas of technical vocabulary and syntactical complexity which potentially have an impact on students' understanding of mathematical word problems. Hence, it is my intention to identify the difficulties that these language features pose for students in learning mathematics in secondary schools in the Solomon Islands.

Interest has emerged and has developed from experiences of teaching mathematics in the Solomon Islands for four years both in secondary and post secondary institutions. I noticed that difficulties in understanding mathematical word problems contributed to poor performance and achievement in mathematics. Another experience that fuelled my interest was the experience of marking national mathematics examination papers in 2000 and 2006. During marking, I observed the poor approach the majority of year nine students from all over the Solomon Islands secondary schools used to solve word problems.

Additionally, I am interested to gather information regarding students' level of proficiency in English. I wanted to find out whether a high level of language proficiency has a link to better word problem solving skills in mathematics. Underlying this is the fact that there needs to be an understanding of the relationship between the language and mathematics (Moschkovich, 2007). An understanding of this relationship will enhance a teaching approach that addresses the language difficulties experienced by students.

1.3 The research questions

Research has been done internationally including New Zealand on areas that are related to the roles of language in students' proficiency and performance in mathematics and word problems (Abedi & Lord, 2001; Garegae, 2007; Latu, 2005; Neville–Barton, & Barton, 2005; Xin, 2008). Word problems are a major component of secondary school mathematics as far as the Solomon Islands mathematics curriculum document is concerned (Ministry of Education, 1997). Thus this study will focus on exploring the role that language plays in solving mathematical word problems for the Solomon Islands secondary school students.

The research questions are as follows.

1. What are the influences of English language proficiency in solving of word problems in secondary schools students of the Solomon Islands?

2. How does difficulty in linguistic features like vocabulary, phrases and syntactical features cause difficulties in comprehension and solving of mathematical word problems?

3 What are the students' perceptions of the sources of difficulty for solving mathematics word problems?

1.4 Significance of the study

The evidence and other information gathered in this research could be important for the Ministry of Education. Curriculum officers and teachers could use the findings of this research as a basis for policies, practices and pedagogical techniques that would address the difficulties faced by students in language and word problem solving. I believe findings would encourage educational leaders to strongly consider setting a curriculum framework that addresses effective teaching of mathematics in the lower secondary schools of the Solomon Islands.

1.5 The context of study

This research was conducted in the context of the Solomon Islands. Hence, the following sections briefly outline the geographical, physical and educational context of the country.

1.5.1 The geographical and physical features

The Solomon Islands are a group of islands in the South Pacific region. The Solomon Islands is located to the east of Papua New Guinea and west of Vanuatu. It has the second largest land area in the Pacific with about 28,370 square kilometres and is about 1900 kilometres northwest of Australia. The islands consist of mostly rugged mountains with low lying atolls and man-made islands. The country comprise of nine provinces with the capital being Honiara, situated in Guadalcanal. The other eight provinces are Malaita, Western, Choiseul, Renbell, Temotu, Ysabel, Central and Makira. Each province has its own centre with the function of administering the affairs of each province. Apart from these provinces, there are 992 islands, 347 of which are inhabited. Most of these are sparsely populated (Pollard, 2000).

The Solomon Islands have diverse languages and customs. Of the estimated population of about 518,338, more than 93% are Melanesian with the minority races being the Polynesian and Micronesian making up approximately 5% of the remainder (Akao, 2008; Malasa, 2007; Malefoasi, 2009). Christianity is now the major religion in the Solomon Islands with five mainstream denominations: Anglican, Roman Catholic, South Seas Evangelical Church, United Church and Seventh Day Adventist Church (Akao, 2008).

1.5.2 The education system

The education system in the Solomon Islands is governed by the Education Act of 1978 (The Solomon Islands Government, 1996). The Act sets the law and provisions that regulate the decentralization and administration of schools both primary and secondary as well as national assessment procedures for examinations and selection. The government, through the Ministry of Education, is responsible for the production and effective delivery of available learning materials and equipment, teacher training and professional development (Ministry of Education, 2004). Formal education was introduced in the late 19th century by Christian Missionaries for the purpose of learning and reading the Bible (Ministry of Education, 2000, 2004). The church missions continued to provide basic schooling until World War II (Wasuka, 1989). From World War II until the 1960s, there was a steady increase in government involvement in education (Wasuka, 1989) with the hope that this would improve the quality of education, groom leaders for the future and help provide people with skills to resource the emerging private sector (Bennett, 1982; Ministry of Education, 2004; Wasuka, 1989). Education was in many ways, a step to employment in the formal sector and a pathway from rural to urban life (Ministry of Education, 2004).

In the late 1960s, the government and the Anglican Church provided the first local opportunity for secondary education. Prior to that secondary education was only available overseas (Potter, 2005). With the support of other Christian organizations, the number of secondary schools then expanded to nine, which became the national secondary schools of today (Potter, 2005). The national secondary schools were, and still are, boarding schools taking students from any province (depending on students' choices and academic performance). However, five of them are either in Honiara or very close to Honiara which is on the island of Guadalcanal. Today, the central government still runs two secondary schools, with the remainder supported by provincial Education authorities, Christian organizations and local communities (Potter, 2005).

The Solomon Islands Ministry of Education Anual Report (2007) reported 184 secondary schools in three categories with a total enrolment of 34,083 in 2007. These schools are spread all over the country and are built according to the needs and wishes of the communities. There are three types of secondary schools operating within the Solomon Islands Education system. These are community high schools), provincial secondary schools and the national secondary schools (Ministry of Education, 2004, 2007).

The community high schools were established in the early 1990s. Most of them are urban, rural and community-based and are administered by the churches and provincial education authorities. Most are amalgamated to the existing primary schools and enroll students up to Form 3 (age 13), with a few going up to Form 6 (age 16) (Malasa, 2007; Ministry of Education, 2004). There are also a few community high schools that reach up to Form 7. About 159 community high schools operate in the Solomon Islands (Ministry of Education Anual Report, 2007). Out of the 159 community schools, 33 are boarding and 126 are termed as day schools (Ministry of Education, 2004, 2007). The community high schools were established in response to community pressure because of the limited capacity of government to provide trained teachers, equipment and curriculum support materials (Ministry of Education, 2004).

There are 16 provincial secondary schools which are located in the country's nine provinces and are administered by their host provincial governments, including the Honiara City Council (Malasa, 2007; Ministry of Education, 2007). In these sixteen provincial secondary schools throughout the country the total enrolment was 5,558 in 2007. These schools enroll students from Forms 1- 6 (ages 11 to 16), with the majority of the students taken from the host province (Malasa, 2007; Ministry of Education, 2004; Walani, 2009). Provincial secondary schools were established in the 1980s to expand the number of junior secondary school places and emphasize the need for acquiring practical subjects (Ministry of Education, 2004).

The national secondary schools are administered by national government through the Ministry of Education or the churches. Being national schools, they enroll students from all over the country from Forms 1 to 7 (ages 11 to 17). There are currently nine national secondary schools throughout the country (Ministry of Education, 2004; Potter, 2005)

1.5.3 The secondary education system

Secondary school education in the Solomon Islands covers the full curriculum of education provided in accordance with Government-approved curricula and delivered to students who have completed primary education (Ministry of

Education, 1997, 2004). Secondary schools are established to expand all the knowledge subjects studied in primary schools. These include English, mathematics, social studies, business studies and other subjects deemed to be important for intellectual and physical development and to develop specialized skills (Ministry of Education, 2004). All students enrolled in these schools follow the one academic national curriculum, which Treadaway (1996) describes as a localized version of the Cambridge Curriculum. This curriculum is guided by the Education Act 1978 which sets the law and provisions governing its uses (Solomon Islands Government, 1996). The regulations stipulated in the Act are mandatory for all schools in the country (Ministry of Education, 2004, 2005).

Almost the majority of the population does not speak English as their first language. The Solomon Islands is a diverse country in terms of language and culture. This poses difficulties in understanding of English. Most of the students in the Solomon Islands attend schools that use English as the official medium of instruction for teaching and learning. In schools there are difficulties related to English and comprehension of mathematical word problems. With the staircase model of the education system, the problem of learning in a different language is compounded.

1.6 The organisation of the thesis

What follows in this thesis is a literature review which examines current literature on aspects of mathematics and experiences of mathematics and language in some western and developing countries. The third chapter presents the research methodology used in this project. It includes the research methodology, procedures of data collection and ethical considerations. Chapter Four presents the research findings and illustrates the main trends that emerged. Chapter Five discusses the findings. Lastly, Chapter Six which is the conclusion summarizes my research findings, describes the limitations of this study, provides suggestions for further research and presents recommendations to address the gap identified.

CHAPTER TWO: LITERATURE REVIEW

2.0 Introduction

Mathematics educators are concerned with students' low ability in comprehension and solving of word problems (Bernardo & Calleja, 2005; Erktin & Akyel, 2005). Solving word problems is an essential part of mathematics in the world today (Bernardo, & Calleja, 2005). However, many English language learners experience that their difficulties with word problems are the rooted in the linguistic features of the word problems (Bernardo, 2002). This also holds for a country like the Solomon Islands which uses English as the official language and for learning of mathematics. Thus, this chapter explores some aspects of English language which are claimed to impact on the learning and solving of mathematical word problems.

This chapter begins with the linguistic description of mathematics as a language and its important roles in mathematics learning. This is then followed by a section that describes the essential features of mathematical language. It begins with an account of mathematics register which comprises different levels of vocabulary, symbols and a specific syntax and notes current research pertaining to these areas. There is a section dealing with English proficiency in relation to mathematical understanding. An important area in this regard is the relationship of proficiency and performance in mathematics.

Another main component of this literature review is the mathematical word problems. Sections here include the general descriptions, features and importance of word problems in mathematical learning. A section also gives the common types of word problems. There is mention of the process involved in solving word problems which comprises four phases and the areas of difficulties in word problems. There is a section on the connection between knowledge and comprehension. The chapter concludes with a summary and introduces the gap found in the literature concerning the Solomon Islands context.

2.1 The language of Mathematics

Language exists in all societies and communities for the purpose of communication. In many school subjects, including mathematics a specific type of language is used for teaching and learning. Mathematics is commonly classed as a language (Adams, 2007; Wakefield, 2000; Wheeler & Wheeler, 1979) despite not being a used as a natural language in a particular society (Pimm, 1991). Adams (2003) explains that the validity of the language of mathematics is inscribed in its structure and uses. Wakefield (2000) holds that mathematics is a language because of the attributes it shares with any natural language: abstractions, symbols and rules, expressions and understanding.

Mathematics is regarded as a foreign language (Bechervaise, 1992, Kotsopoulos, 2007, Usiskin, 1996). This holds for the Solomon Islands students who are learning mathematics in English. Underpinning this is the fact that mathematical language is only learnt in schools during mathematics lesson. It is not a language learnt and spoken at home. At the same time, the words that are used to explain the concepts are foreign to the Solomon Islands students. Mathematical English is foreign as it is made up of a large portion of the natural language of English and other foreign languages like Greek and Latin (Peat, 1990). When students learn mathematics, they are effectively learning a second foreign language.

In addition to being a foreign language, certain experts view mathematics as more than a language (Bullock, 1994; Gough, 2007; O'Halloran, 1999; Peat 1990; Weinzweig, 1982). According to Weinzweig (1982) mathematical language can be termed an extension of the natural language. It involves visual and sensory thinking which is not part of ordinary language. This is evident in the branch of mathematics that deals with relationships and properties of shapes. This branch does not involve the same thinking processes as ordinary language. This non-verbal thinking appears to involve mental activity that extends beyond the area of written and spoken language (Peat, 1990). Gough (2007) explains that this non-verbal language is represented by tables, rows, columns, pictures, diagrams and graphs. O'Halloran (1999) further claims such visual displays cannot be clearly explained in everyday natural language. That is to say, certain mathematical representations cannot be explained using the everyday language.

In the Solomon Islands, the type of mathematics taught is viewed as Western mathematics because it uses a mathematics curriculum that was introduced by Great Britain (Treadaway, 1996). This contributes to the challenges surrounding the learning of mathematics. Even when Solomon Islands students learn to read in ordinary English, there are new hurdles for them to master in mathematical English. Hence, students must be proficient in English in order to be successful in this language which is foreign, in addition to being well versed in the use of mathematical register

2.2 The role of language in mathematics learning

Mathematics learning draws on language (Schleppegrell, 2007). The role of language is prominent in teaching and learning of mathematics (Huang & Normandia, 2007). It plays an important role in facilitating the learning and understanding of mathematical concepts. Language is used to express mathematical ideas and link mathematical relationships and patterns (Han & Ginsburg, 2001). An area in which language and mathematics intersect is in carrying out computation, word problem solving and reading textbooks (Moschkovich, 2007). Wheeler and Wheeler (1979) point out that mathematics is a language used widely to express ideas regarding shape, size, quantity or order. It is the language that is used unconsciously every day by many people. For example, if we want to describe the shape of the earth, we use the language of shapes which is the language of mathematics (Bullock, 1994). It is used to describe our understanding of the physical universe, to facilitate business transactions, and to analyse and understand the complexities of the modern society (Wheeler & Wheeler, 1979). It is a tool with which students learn mathematical concepts. Perhaps an underlying reason is that, mathematical concepts are hierarchical and connected (Raiker, 2002). This hierarchy provides a layer of concepts that are connected and inter-related. Students use language to name numbers, manipulate ideas, share and explore ideas and solve word problems. Barwell (2005) agrees that mathematical language involves not just vocabulary and its technical usage; it also includes ways of using language to explain, argue and describe an idea.

2.3 Features of mathematical register

As previously mentioned, mathematical language is a foreign language (Bechervaise, 1992; Kotsopoulos, 2007; Usiskin, 1996) and has characteristics beyond a spoken language (Weinzweig, 1982; Peat 1990). Besides this, from a linguistic perspective, mathematical language constitutes a particular register. According to Hucker (1994) and Moschkovich (1999), the mathematical register consists of everyday language, technical vocabulary and symbolic language and syntax. Hence, firstly I will examine the register of mathematics. Later, I will explain the components of the register which include levels of technicality of vocabulary, system of symbols and its syntactic aspect.

2.3.1 Mathematics register

The concept of mathematics register emerged from the linguistic concept of language register (Cuevas, 1984; Farrugia, 2006, Halliday, 1975; Schleppegrell, 2007). A register refers to the type of language used in a specific situations or context. Halliday (1978) defines register as, a set of meanings that is appropriate to a particular function of language, together with the words and structures which express these meanings. Thus, the mathematics register has meanings that belong to the language of mathematics and that can be used for mathematical purposes and situations (Moschkovich, 2002). Likewise, Cuevas (1984) defines the mathematics register as having words belonging to natural language but used in mathematics specifically. A particular situation creates meaning of a term and that term is only used for that particular situation. Thus, for an everyday occurring word, the situation for which it is used in mathematics creates a totally different meaning to it from each everyday meaning. This meaning is normally more specific only to a mathematics context.

Meaney (2005) points out that the mathematics register consists of the vocabulary and grammatical expressions that occur frequently when mathematics is discussed. For example, the word *fraction* is part of the natural language which has a different meaning in the context of mathematics. Having said this, English language learners describe learning mathematics as twofold. It includes mathematical concepts to be learnt and learning and understanding the mathematical meanings of words (Moschkovich, 2007). This is because, there are words extracted from the natural English language yet used to describe a mathematical concept that is only seen in a mathematical situation.

Mathematical register and everyday register are not separate and should not be obstacles to mathematics learning (Moschkovich, 2007; Schleppegrell, 2007). These two registers do not function separately, but students and teachers may interweave these two registers in their mathematical classroom for effective learning (Forman, 1996). Everyday meanings do not always create difficulty in the understanding of mathematical concepts but may provide resources to facilitate the understanding of mathematical concepts (Moschkovich, 1999). Hence, the mathematical register helps students construct mathematical meanings from the ordinary meanings to suit the mathematical situation (Schleppegrell, 2007).

2.3.2 Levels of technicality in mathematics vocabulary

Mathematics language is highly technical with specific vocabulary that is directly connected to the content (Huang, Normandia & Greer, 2005; Montague, Krawec & Sweeney, 2008; Schleppegrel, 2007). The mathematical vocabulary is part of the mathematical register (Farrugia, 2006). It is a very important and complex area as far as mathematical learning is concerned. Mathematical vocabulary consists mainly of vocabulary which can be divided into non-technical and technical terms.

The non-technical category of mathematical language mostly consists of words that are obtained from everyday English language (Hucker, 1994; Moschkovich, 2002; Padula, Lam & Schmidkte, 2002). Shuard and Rothery (1984) see these types of words occurring in both everyday English and mathematical English. Most of these non-technical words are words that are used daily in conversation and in writing. These are words are not highly mathematical like *place, borrow* and *side* and appear to carry the same meanings in English (Schleppegrel, 2007). The everyday meaning of the mathematical words can be used to simplify the specific meanings of the mathematical words. For example, the meanings of words such as *rise* and *run* help to simplify the meaning of the specific meaning of *gradient* which indicates the steepness of a straight line (Ministry of Education, 1997).

More examples of technical vocabulary are at the other end of the spectrum and are also derived from ordinary English (Chapman 1993; Gough, 2007; Schleppegrel, 2007; Shuard & Rothery, 1984). These are vocabulary items which have specialised meaning in mathematics and so are much applied to mathematics contexts (Halliday, 1975). Some examples of these words are *multiplication, axis, divisor set, point, field, column, sum, even, random, operation, equal, irrational, table, volume, show, product, change, integration and power* (Adams, 2003; Gough, 2007; Hucker, 1994; Raiker, 2002; Padula et al, 2002; Shuard & Rothery,1984). These technical words are used with special mathematical significance and meanings which exist only in mathematics (Shuard & Rothery, 1984). For example, the term *integration* when used in mathematical discourse has a specific meaning unrelated to the sociologist's meaning of racial integration (Padula et al., 2002). Gough (2007) states that *volume* in mathematics does not only mean turning the knob or the slider-control on the stereo-system or television which we adjust to make the sound louder, nor it is a separately bound part of a multi-book publication. In the context of mathematics, it is the total space occupied by a solid, filled by a three dimensional object. Another example is the word *show*, which in the context of mathematics becomes an instruction to prove or justify mathematical statements or formulae, rather than having its ordinary meaning to display or point out (Gough, 2007).

Some of this very technical vocabulary is borrowed from other languages. These are words at the very technical end of the spectrum. Examples of some of this technical vocabulary are *sine, cosine, tangent, quadratics* and *polynomial* (Kidd, Madsen & Lamb, 1993; Ministry of Education, 1989, 1997). Mathematical terms like *ellipse, hyperbola* and *parabola* are borrowed from the Greek language (Usiskin, 1996). Halliday (1978) also explains words like *series, subtract, acute, binary* and *frequent* have their origin in the Latin language and the words such as *domain, evaluate* and *multiple* are obtained from French. Likewise mathematics uses terms such as *parabola, hyperbola* and *radius* which are borrowed from Latin and Greek languages (Cuevas, 1984). Many times the words are used to explain new concept that does not have any similarities in the ordinary English context, let alone the languages of the Solomon Islands. These words do not refer to anything in ordinary English and so it is presumed that students will have difficulty in understanding them.

Technical words and phrases collected from other languages are used primarily to explain certain mathematical concepts that are difficult to explain in plain English language. Students are unfamiliar with those words in the early stages of their mathematical learning. Nevertheless, these terms can be explained with words that are part of ordinary English. For example, words that are used to explain the concept of *tangent* include *opposite*, *adjacent, sides* and *angles.* These are used in relation to the geometric figure of the triangle for the purpose of clarifying the concept pertaining to *tangent* (Ministry of Education, 1997).

A link between everyday and mathematical meanings of words needs to be created by learners if possible. Learners must be able to shift from the everyday meanings of words to the more specific mathematical meaning of these words. Solomon Islands mathematics learners may not fully develop a greater mathematical register. With this limitation, learners cannot move smoothly in between the everyday meaning and the mathematical meanings of the terminology in mathematics.

2.3.3 Mathematical symbols

Apart from having technical and non-technical terminology mathematics register also encompasses a system of symbols (Adams, 2003; Cocking, 1988; Hucker, 1994; Schleppegrell, 2007; Wadlington & Wadlington, 2008). A symbol is a sign that stands for or refers to something (Chapman, 1993). A few of the many mathematical symbols include %, $, +, -, =, > and < (Latu, 2005; Wadlington & Wadlington, 2008). Like the mathematical vocabulary, some mathematical symbols are written using letters borrowed from other languages. For example, Usiskin (1996) states that mathematics borrowed letters like π from the Greek language and uses it to represent for a constant number. Other Greek alphabet letters like α, β, μ and $\sum$ are also part of the register of mathematics. Likewise, Hebrew letters such as aleph, and Roman numerals and extra non-alphanumeric characters like × and ÷ are used as symbols in mathematics (Gough, 2007).

In mathematics symbols have important roles in learning and teaching (Adams, 2003). One of these roles is to indicate the operation to be performed. For example, in the numeric operation of 30 x 6, x is a standard symbol indicating the operation of multiplication (Adams, 2003; Chapman, 1993). Symbols are purposely established in mathematics to make sense of and to standardise mathematical meanings and concepts (Marks & Mousley, 1990). Weinzweig (1982) and Schleppregell (2007) perceive that the symbols in mathematics also describe patterns between different quantities in mathematics. For instance, the symbol of 6 is associated with the meaning of quantity. Its meaning can be derived from counting, ordering or may be a result from any of the arithmetic operations. Similarly, the symbol : is normally used to show the mathematical concept behind proportional relationship amongst quantities (Ministry of Education, 1997). This symbol is used in an inverse and co-variance relationship. Additionally, as Fuentes (1998) states the symbol + is associated to the equivalent meanings of sum, plus, increase, positive, add, more, group and combine. In this way, mathematical symbols help in explaining the concepts that cannot be explained using ordinary language (Schleppegrell, 2007).

2.3.4 Mathematical syntax

The mathematics register also includes syntax (Moschkovich, 1998, 2007). Wheeler and McNutt (2001) define syntax as being the organisation of words in a sentence. Syntax is the order, relative size and arrangement of the text in a meaningful way (Pimm, 1987; Sampson 1975). Syntax means the way words, linguistic items and phrases are arranged and combined to show relationships and meanings within a sentence (Crystal, 1997; Richards, Platt & Platt, 1992). Martiniello (2008) explains syntax as involving the arrangement, order and appearance of words and phrases in mathematical word problems. Nation (1990) and Richards (1976) explain the syntactic property of a word as its collocation relations with other words in the sentences and the frequency of appearance in specialised texts. For the purpose of this research, the definition of syntax of a word problem encompasses all the features namely the size, phrases and the order in which words appear in a mathematical word problem.

Size of a word problem can be affected by the syntax. The size of a word problem can range from one sentence to several sentences. Syntax also includes long noun phrases which participate in constructing the meaning in word problems (Mayer, 1982). A phrase that sometimes appears in mathematical word problems is *twice as long as* and is used to show a relationship between two quantities. This can be used to describe the comparison between two different lengths, sizes, ages and heights. Hence in mathematical word problems, syntax is very important as the underlying concept is embedded in it.

2.4 Challenges in mathematical vocabulary

In the previous sections, I have discussed mathematical register and its components. This section deals with challenges experienced internationally and in some students of the Pacific concerning mathematics especially vocabulary. These difficulties are common to students with backgrounds of language other than English (Padula et al, 2002).

One of the common difficulties in mathematical word problems is found to be linked to mathematical vocabulary (Garegae, 2007; Martiniello, 2008; Padula et al, 2002, Wheeler & McNutt, 2001). The difficulty lies in the understanding of the technical vocabulary in mathematics. The foreign nature of technical vocabulary sets a difficult platform for students' understanding. For example, Garegae (2007) found that poor understanding and competence emerged from a misunderstanding of mathematical terms. Most mathematical terms are difficult to students because of the specialised mathematical meanings they carry which are unfamiliar to the students (Martiniello, 2008; Stickles & Stickles, 2008; Wheeler & McNutt 2001). Gough (2007) suggests that problems in mathematics are "encountered when technical words are in conflict with the everyday understanding" (p. 8). Vocabulary difficulty is related to connecting different meanings, interpretation and relationships to mathematical operations in mathematical word problems (Van de Walle, 2004). Similarly, Cummins, Kintsch, Reusser and Weimer (1988) and Riley and Greeno (1988) uphold that difficulty in understanding the vocabulary of certain types of terms in mathematical problems leads to more errors in the solution of problems.

Studies conducted with some Pacific students have shown similar problems with mathematical vocabulary (Latu, 1999, 2005; Neville – Barton & Barton, 2005). For example, Latu (2005) and Neville-Barton and Barton (2005) found that the technical vocabulary of mathematical English was a major cause of difficulty in learning mathematics for Pasifika and Chinese students. Perhaps, the difficulty in vocabulary exists because there is not a one-to-one matching of these terms in the home language (Fasi, 1999). To exemplify Fasi (1999) reveals the mathematical concepts like *absolute value, standard deviation* and *simultaneous equations* were found to have no reference to any Tongan cultural activities. Furthermore, Latu (2005) explains that there is confusion surrounding terms like *factorise* and *simplify* for Polynesian students. These are factors that are seen to have negatively impacted on the mathematical learning process of these Pacific students.

Most of the studies indicated gaps in mathematics teaching which needs further exploration. For example, Latu's (2005) study, which was conducted on year 12 students only in Tonga, found that algebraic terminology was difficult. Neville-Barton and Barton (2005) worked with students in a country where Enlgish language is spoken and used by citizens as the first language. Hence, there are facilities and programs in place for the improvement of the proficiency in English. Fasi (1999) looked at concepts of mathematics in the Tongan context. It would be useful to investigate the vocabulary difficulties experienced by students at the lower secondary level. Latu (2005) only worked with Pasifika students from the Polynesian race who may have lived in New Zealand for so long and would have been more exposed to the English language. There should also be studies to also investigate the level of difficulty experienced by the lower secondary sector. It will be interesting to conduct research on word problems with Melanesian students

In the Solomon Islands, understanding of vocabulary is essential in effectively learning mathematics. Learning mathematics involves not only involve the traditional way of solving word problems but also oral presentation of mathematical ideas and discussion (Moschkovich, 2002). From this perspective, the understanding and acquiring of vocabulary is a stepping stone to all these other valuable mathematical activities.

2.5 English language proficiency and mathematics

In the previous sections, I have described the complexity of the mathematics register and current challenges concerning mathematics and vocabulary. In mathematics, high proficiency in English language is essential in relation to mathematics and word problem solving (Neville-Barton & Barton, 2005). Studies have shown that there is positive correlation between the level of English proficiency with understanding and performance (Abedi & Lord, 2001; Bernardo, 2002; Clarkson 1991; Zambo & Zambo, 2004). The subsequent sections provide evidence to support the link between English proficiency and mathematical understanding.

2.5.1 The relationship between English proficiency and understanding of mathematics

Studies have been done on the relationship between English language and mathematical performance at both primary and secondary schools (Neville-Barton, 2005; Setati & Adler, 2001). English proficiency has been found to have direct relationship to a high level of understanding of mathematics (Zambo & Zambo, 2004). For example, evidence from a study by Clarkson (1991) on secondary students in Papua New Guinea showed that the errors made by students in a mathematics test were related to misunderstanding of the English language. These were due to poor reading and comprehension of text and were evident in English language learners who have a low proficiency level. The findings suggest that the difficulties students had in relation to understanding intensified in the case of English language learners who have to solve word problems written in their second language.

Similar findings were gained from a study by Abedi and Lord (2001) on year eight students from non-English speaking backgrounds settling in Los Angeles, in the United States. This study was investigating the importance of language and word problems solving. An important outcome of this study was the link that was established between high English language proficiency and performance of mathematics. This study identified that linguistic features like vocabulary and syntax contributed to low performance in mathematics. Low ability students also performed much more poorly when the language was more complex. Evidence from this study suggested that linguistically complex word problems were difficult for students to solve. The level of complexity was in relation to item length and voice of verb phrase. Students were more comfortable with active voice verbs like *would you expect to find* than passive voice verbs like *could be expected to find*. Though the participants were from non-English backgrounds, they were living in a country where English language is the officially spoken language. Thus, it is presumed that students were already exposed to English and would have benefitted from support programs. On the other hand, it is not surprising that high level of proficiency in English is found to be linked to better understanding in mathematics.

A study by Bernardo (2002) in the Philippines showed that English language learners understand word problems better when written in their first language. In this research, two groups participated, those that speak English as their first language, and non-English speakers. The second language speakers could not understand the word problems written in English language. This study supports the notion that proficiency is related to the understanding of the language appearing in the word problems.

Another study which gives detailed evidence to show the relationship between English proficiency and mathematical understanding is that of Meek and Feril (1978) in Papua New Guinea. This study revealed that students with low English language proficiency have difficulty understanding mathematical words. In their study it was evident that out of eleven mathematical words selected from a grade 5 syllabus with three different contexts, only a little more than one third of the total number of students correctly understood only one out of the eleven words.

The above studies reveal an interesting correlation between proficiency and understanding in mathematics. I am interested to know whether the students of the Solomon Islands demonstrate a positive link between language proficiency and understanding of mathematical word problems.

2.5.2 The relationship between English proficiency and performance in mathematics

There are also studies to show the relationship between English proficiency and performance in mathematics. For example, Bernardo (1999) found that Filipino-English language learners performed better when word problems were written in Filipino rather than in English. This may imply that the English language learners in this study preferred to use their own language to learn mathematics. This indicates a strong relationship between the use of the first language and mathematical performance. Additionally, Parvanehnezhad and Clarkson (2008) found that Iranian secondary school students in Australia who are English language learners and have low proficiency in English performed poorly in mathematical word problems. Conversely, their peers who were first speakers of the language performed better in mathematics. Clarkson (1992) found that in Australia the mathematics achievement for learners with English as their additional language was low. Bernardo (2005) in his study of Filipino and English students found that the students whose first language was English performed better in mathematics than the Filipino students. The results suggest that first language speakers of English learn and solve mathematics word problems better when the word problems are presented in English.

Similar trends have been established with bilingual students in countries of the Pacific region. In New Zealand, Latu (2005) found that year twelve Pasifika students who have low level of proficiency in both their home language and English did not perform well in mathematics. Clarkson and Dawe (1994) found that migrant students between years four and eight from Europe, Asia and Arabic countries who lived in Australia with low level of proficiency in both their native language and English experienced cognitive disadvantage. This was perhaps a contributing factor to a low performance in mathematical word problems.

However, these studies fell short of revealing the impact that language proficiency has on the performance of mathematical word problems. Language proficiency is essential for the comprehension of the language of mathematics. The studies did not show what features contribute to poor comprehension of the mathematical task. Hence, this research was designed to investigate the impact on language proficiency and the mathematical understanding of word problems.

Clarkson (1992) found that English language learning students of Papua New Guinea with low proficiency in both English and the local vernacular of pidgin were more disadvantaged in mathematics. This study was conducted on year six students who spoke pidgin and English and students who spoke only English. Findings from this suggest that the level of competence that a student has in both languages can bring advantages for solving mathematics word problems. The level of competence in language is an important factor that must be considered in developing countries such as the Solomon Islands where English is the second language and where students speak pidgin.

2.6 Word problems

In the previous sections I have discussed areas of mathematical language, current challenges in the understanding, and proficiency and performance in mathematics. In this section, I will discuss aspects of word problems. I will begin by considering descriptions of word problems. This is followed by sections on the features of word problems, the importance of including word problems in mathematics and main types of word problems. Further to this, I will explain the process of solving word problems, comprehension and the types of knowledge essential for solving word problems.

2.6.1 Describing a word problem

A central feature in this study concerns word problems, which are an important component of mathematics education and curriculum (Mestre, 1981, Ministry of Education 1997; Moschkovich, 2002; Reusser, 1995; Reusser & Stebler, 1997). Many scholars (Baroody, 1987; Cawley & Miller, 1986; Parkins & Hayes, 2006; Wyndhamn & Saljo, 1997) share similar views on the descriptions of a mathematical word problem. Their views are briefly explained in this section.

Lester (1983) holds that a mathematical word problem is a task which should stimulate individuals to attempt and find a solution. Cawley and Miller (1986) describe mathematical word problems as those whose words and structure pose problems to students. Baroody (1987) emphasises that word problems that need analysis of the unknowns, or that contain too much and too little incorrect data, and problems with more than one correct solution require extended effort. Word problems contain relevant as well as irrelevant information that may be seen as distractors (Mayer, 1982). Word problems require students to go beyond rote learning and apply their mathematical knowledge to a realistic problem situation (Wyndhamn & Saljo, 1997). Similarly, Larkin and Briars (1984) define word problems as the context in which students apply their mathematical knowledge in useful situations. Parkins and Hayes (2006) similarly see word problems as a reflection of real-life situations containing mathematical concepts.

2.6.2 Features of a word problem

Previously, I have discussed the description and intentions of a word problem. A word problem is normally presented in written format. A word problem appears to have a structure that encompasses variables, quantities and grammar (Lepik, 1990; Martiniello, 2008; Mayer, 1982; Xin, Wiles & Lin, 2008).

Most word problems contain a structure that encompasses simple to complex linguistic features. In explaining the simple mathematical structure of a word problem, Verschaffel, Greer and DeCorte (2000) describe the structure of word problem as: the nature of the known and unknown quantities given in the word problem and the kinds of mathematical operations for calculating the solutions from these given elements and certain mathematical relationship in the text. The structure contains mathematical objects and relationships between the objects and their properties. The relationship can be displayed by quantities or objects that show the relationship of being equal, less than or greater than.

An important feature in the structure of a word problem is the variables. A variable in a word problem can be a symbol that represents a quantity. Lepik (1990) says that a variable has linguistic features. Martiniello (2008) and Lepik (1990) exemplify variables as the number of words and letters in a sentence, number of sentences in a word problem and the length of sentences in a word problem.

Quantities constitute another type of variable in a word problem. Lepik (1990) classifies quantities into known, wanted and auxiliary*.* These are related to each other by propositions and the required operation for finding the solution. The known quantities in the problem are the quantities whose values are presented in the problem. Examples of *known* quantities are the cost of items, the distance travelled and the age of a person. These are then attached to numerical values for purposes of calculation. *Wanted or unknown* quantities are named in the problem statement and it is the intention of the problem solvers to solve for these quantities. *Auxiliary* quantities are not named in the problem statement, but are needed for solving the problem. To explain the term *auxiliary* quantity, consider the following sample word problem:

> Find the area of a right triangle with the length of the hypotenuse 5cm and the length of the base 3cm.

In this word problem, the *known* quantities are the hypotenuse and the length of the base of the triangle, the *unknown* quantity is the area and the auxiliary quantity is the height of the triangle. It is not clearly presented but students have to find it before they can use it to find the unknown quantity which is the area of the triangle.

Grammar is important in establishing the structure and goal of word problems (Xin et al, 2008). For example, the grammatical pattern established by the dense noun phrase, *volume of a rectangular prism with height of 12cm, length of 10cm and breadth of 30cm,* provides the problem solver with the structural quantities to reach the goal of the word problem. It has the role of directing the attention of individuals to key elements of the word problem such as the mathematical terms, quantities and mathematical intention. Hence, grammar provides guidance for students to understand a word problem. A word problem that is written with grammatical errors sometimes misleads students.

2.7 The importance of word problems in mathematics learning

Different types of word problems appear in mathematical textbooks with the intention of provoking students to think and apply their mathematical knowledge to find solutions. The importance of mathematics and word problems have been emphasized since the 1980s (Baroody & Hume, 1991; De Corte, Greer & Verschaffel, 1996; Xin, 2008). Prior to that, word problem exercises were used for application of algorithms of addition and subtraction. In the Solomon Islands before the introduction of word problems in mathematics the subject focused mainly on numeracy and basic arithmetic operations like addition, subtraction, multiplication and division. This was intended to assist Solomon Islanders in practical subjects like carpentry and agriculture and thought to help equip people with skills needed in the private sector (Walani, 2008).

Nevertheless, there are a lot of important reasons for mathematics teachers to offer word problems as a major part of learning mathematics. Word problems give students a glimpse into how mathematics is used in the real world. Wyndhamn and Saljo (1997) point out that in word problem solving mathematical skills and insight are put to real test. Verschaffel, Greer and De Corte (2000) similarly argue that word problems provide opportunities for students to use mathematical tools to create the link between mathematics and real-life contexts and to encourage thinking. Likewise, Reusser (1985) holds that word problems are an important part of mathematics education because they represent the interplay between mathematics and reality. In this way, mathematical word problems tasks encompass a possible situation in an everyday context.

Martinez (2001) maintains that meaningful word problems are more effective than traditional exercises in engaging students in comprehensive and active learning. Xin (2008) argues that providing word problem solving opportunities emphasise mathematical thinking and reasoning and are regarded as critical for conceptual understanding. Word problems encourage students to think mathematically and to develop problem solving strategies rather than relying on memorized procedures. These are skills needed in the 21st century for jobs (Jitendra et al, 2001). Hence, introducing mathematical word problems in schools is important to promote and develop-higher learning and future employment.

2.8 Types of word problems

A number of scholars, such as Christou and Phillipou (1998), Kintsch and Greeno (1985), Lewis and Mayer (1985), Garcia, Jimenez and Hess (2006), Fuchs, Seethaler, Fuchs, Powell, Hamlet and Fletcher (2008), Heller and Greeno (1978) and De Corte, Verschaffel and De Win (1985), have categorised word problems into three types: change, compare and combine. Most of these word problems are commonly used as part of the curriculum of Solomon Islands secondary schools, having been introduced in year eight (Ministry of Education, 1997).

Griffin and Jitendra (2009) state that change, combine and compare problems are additive problems which have the characteristics of addition and subtraction. The following sections further explain these types of mathematical word problems.

2.8.1 Change problems

One of the common types of arithmetic word problem involves change. A change word problem has an initial quantity and a direct or implied action that increases or decreases that initial quantity (Fuchs et al, 2008; Garcia, et al, 2006; Riley et al, 1983). Griffin and Jitendra (2009) refer to these three sets of information as the beginning, change and ending. An example of a change problem is given by Garcia et al (2006) as follows:

> Pablo has 18 stickers. His friend Juan gave him 6 more stickers. How many stickers does Pablo have altogether?

A change problem involves increasing or decreasing a starting quantity to end up with a new quantity. In a change word problem, the action that increases the initial quantity is addition and subtraction is the operation that decreases the initial quantity. The final quantity can be either greater or smaller than the initial quantity or the beginning set. Further, Riley et al (1983) point out that in a change problem, any of the items can be calculated when any of the other two quantities are given. For example, once the initial quantity is given and the change in that word problem is identified, then the resultant can be calculated. Here the final quantity will be greater than the initial quantity. On the other hand the final quantity will be less than the initial quantity if there is subtraction happening between the initial quantity and the change quantity.

2.8.2 Combine problems

A combine problem is another type of arithmetic word problem. Garcia et al (2006) observe that it "involves the static relationship existing between a particular set and its two disjoint subsets" (p 271). The static relationship results from adding the quantities in the subsets. As Fuchs et al (2008) further pointed out, a combine problem is a "total problem that combines two or more quantities to make a total" (p 165). Fuchs et al (2008) illustrate a combine problem as follows:

> There are 51 boys and 47 girls in the third grade of Baker Elementary school. How many third graders are there in Baker Elementary school?

In this word problem, one of the sets is represented by the proposition 51 boys and the other set is denoted by the proposition 41 girls. These quantities are referred to as the subsets. The total set is taken from the proposition *How many third graders are there in Baker Elementary school*? In this type of word problem the choice of operation is either addition or subtraction and depends on the relationship between the set and the subsets. This is determined by the question proposition. For example, a phrase like *How many boys are there altogether*? indicates that the goal is to find the third set by addition. On the other hand, the question having the proposition 'left' or 'remaining' indicates the mathematical operation of subtraction to obtain the final set.

2.8.3 Compare problems

Another type of word problem is the compare problem. In a compare problem, there is a static relationship in which there is a comparison of two separate quantities (Carpenter & Moser, 1983; Garcia et al. 2006). Carpenter and Moser (1983) label the sets as the referent, the compared and the difference set. Comparison is done "between a bigger and smaller quantity to find the difference. In finding the difference in a compare problem, the implied action is subtraction. Garcia et al (2006) present an example of a compare problem as follows:

> Olivia's bicycle has 14 gears and Alba's bicycle has 9 gears. How many fewer gears does Alba's bicycle have than Olivia?

In this word problem, the referent set is Olivia's gears, the compared set is Alba's gears and the difference is indicated by the proposition *How many fewer gears does Alba's bicycle have than Olivia's?* However, in some instances, the choice of the position of the unknown is decided by the teacher or whoever is setting the word problem, such as an examiner. Nevertheless, in a compare problem, the larger set can be either the referent set or the compared set (Carpenter & Moser, 1983). Likewise, Carpenter and Moser (1983) maintain that change, combine and compare word problems involving addition and subtraction are designed only for primary school students. However, in the context of Solomon Islands mathematics, these are also prescribed for secondary school students and, as noted above, are introduced in year eight (Ministry of Education, 1997).

Several studies have been conducted on the degree of difficulty of the arithmetic word problems of change, combine and compare. Riley, et al (1983) found that the most difficult of the three types of arithmetic problems is the compare problem. The main difficulty found was related to identifying the unknown quantity. It would be interesting to investigate whether vocabulary contributes to the difficulty in identifying the unknown. Additionally, De Corte et al., (1985) and Garcia et al., (2006) found that the difficulty increased when the unknown was the starting set instead of the change quantity. An example of a word problem with initial unknown quantity is presented by Riley et al (1983) as follows:

> Emily had some marbles. Then Ana gave her 8 more marbles. Now Emily has 14 marbles. How many marbles did Emily have in the beginning?

Carpenter and Moser (1984) point out that the main problem is in representing the change problem in a model, because the unknown is the initial quantity.

2.9 The process of solving word problems

To solve word problems, students must interpret and analyze information as the basis of making selections and decisions (Cawley & Miller, 1986). The procedure in order to find the solutions may not be easily accessed and so students need to use experience and ability to comprehend the language of the word problem. This is because there is more than one step to solve a mathematical word problem (Baroody, 1987). Hence, it is essential to understand the cognitive processes involved in solving word problems. Word problem solving is a cognitive process in which students need to create relationships to gain meaning from the word problem (Zambo & Zambo, 2004). There are four aspects in solving a problem: reading, comprehension, solving, and rechecking the solution (Adams, 2003; Polya, 1945). These aspects are described below but do not necessarily happen in the order presented. The process of solving word problems can also take longer for some students, depending on their mathematical ability and other factors like reading which may affect their cognitive process.

2.9.1 The reading aspect

The first aspect involves reading and is linked to the process of comprehension. (Zambo & Zambo, 2004). It involves creating relationships between items and information that are presented in that particular word problem (Marschark & Hunt, 1989; Zambo & Zambo, 2004). It involves an exchange between the reader and the text for a particular task or purpose (Martiniello, 2006). In many instances, students look for the key words of the problem without properly reading the problem (Adams, 2003). Sometimes they will miss or skip the important information.

2.9.2 The comprehension aspect

The second aspect involves comprehension, when students are required to attend to the important elements of the word problem. In the word problem solving process, comprehension is an essential step associated with reading (Kintsch & Greeno 1983; Polya, 1945; Vilenius-Tuohimaa, Aunola & Nurmi, 2008; Zambo & Zambo, 2004) Comprehension involves the activation of contextual, language and mathematical schemas (Zambo

& Zambo, 2004). Comprehension is the meaning–making process that involves reciprocal exchanges between the reader and the text (National Reading Panel, 2000), the process of constructing meaning from print (Graham & Bellert, 2005). It should capture the patterns and relationships and the link between the word problem and the appropriate mathematical operations (Jitendra, 2001; Marshall, 1995). Important features of the word problem are the vocabulary level, the context/setting and other extra information such as the auxiliary unknowns and syntactic features. In many cases, students have to revisit the previous stage in order to support their understanding. The task of comprehending a word problem text requires constructing from the text a conceptual representation upon which the problem-solving processes can operate. Vilenius–Tuohimaa et al., (2008) suggest that in reading comprehension technical reading level affects the comprehension of word problems. Better comprehension skill will lead to the better solving of word problems.

Mathematically, comprehension is a vital skill which is beyond the normal skill of comprehension and must be acquired by all learners in order to be successful in word problem solving. In this aspect of problem solving students adopt the process of translation (Hinslay et al, 1977; Mayer, 1982 Lawrence, 2009), when they convert the problem text into a mathematical equation for the purpose of solving it (Hinslay et al, 1977). This is through translating the real situation into a mathematical term (Stebler & Ruesser, 1997).

2.9.3 The solving aspect

The third aspect involves solving the word problem. At this stage students process information and retrieve previous knowledge related to the problem at hand (Wong, 1994). Students utilise their conceptual understanding to create an appropriate mathematical strategy. Strategies can be taught by teachers or students could resort to a trial and error approach (Adams, 2003). Children tend to construct a set of special strategies for establishing conceptual mathematical mental representations that are appropriate for applying mathematical operations (Kintsch & Greeno, 1985) The strategy for solving word problems involves the selection of the appropriate operations that will yield the correct solution. Also in this phase, formulas can be established and used to solve the word problems in algebra (Hinslay et al, 1977; Lawrence, 2009). Furthermore, equations can be established in order to come up with a solution. In this aspect, the students apply their mathematical skills and reasoning abilities (Wyndham & Saljo, 1997). Diagrams can also be drawn to simplify the complexity of the word problem (Wong, 1994).

2.9.4 The rechecking aspect

The final phase is when the students to look back and reflect on their solution. Looking back provides an opportunity for students to check the accuracy of their solutions. A possible error in the word problem can be detected at this stage and can be rectified. If the solution is incorrect, then students can re-start the whole process beginning with the reading aspect.

In the four aspects of solving mathematical word problems, important skills are required. The skills are needed in reading and comprehension, selecting the data needed to solve the word problems, choosing operations, translations of the problem into numerical equations and computing of the word problems (Hong, 1995).

2.10 Essential forms of knowledge for solving of word problems

The four aspects of the process of solving word problems just described involve language and are related to knowledge of vocabulary and syntax. These two forms of knowledge are essential for a conceptual understanding of mathematical word problems. Thus, the subsequent sections deal with aspects of vocabulary and syntactic knowledge.

2.10.1 Vocabulary knowledge

It had been stated earlier in this chapter that mathematical language has its own register (Cuevas, 1984; Halliday, 1978). This register has been shown to comprise vocabulary that ranges from ordinary to highly technical and specialised meanings (Halliday, 1978; Meany, 2005).Thus, it is essential that English language learners acquire a level of vocabulary knowledge that will contribute to raising their competency level for mathematics. Generally, vocabulary knowledge is about how many words a learner knows and how much he or she knows about a particular word (Read, 1993).

Nation (1990; 2001) has established a framework in regards to the concept of vocabulary knowledge from a practical perspective that has proved useful for classroom teachers. It includes the receptive and productive aspects of a word. The receptive aspect of a word is associated with listening or reading and comprehension whilst the productive aspect relates to speaking and writing (Nation, 2001). These aspects include the form, meaning and uses of a particular word (Nation, 2001; Qian 2002; Zhang & Anual, 2008). The form of a word includes the spoken as well as the written form whilst the meaning includes concept, reference and association. The uses of a word encompass grammatical function, collocation and the limitations to the uses such as register and frequency (Nation, 2001). Hence, in mathematics it is presumed that English language learners need to have competency in both the receptive and productive knowledge of a word to be able to understand, translate and solve mathematical word problem.

Researchers also maintain that there are two dimensions to vocabulary knowledge: breadth and depth (Nassaji, 2004; Nation, 2001; Qian, 1999, 2002; Read 1989; 2000; Wallace, 2008; Wesche & Paribakht, 1996). According to Qian (1999), breadth of vocabulary knowledge is defined as "vocabulary size, or the number of words for which a learner has at least some minimum knowledge of meaning" (p 283). Nation (2001) takes vocabulary knowledge to mean the number of words a learner knows at a particular level of language proficiency. There are assessment tools that were used to measure the level of vocabulary knowledge of students. It would be interesting to know whether the same tools could be used to assess the mathematical vocabulary knowledge of English language learners.

Qian (1999) and Nassaji (2004) refer to depth of vocabulary knowledge as the learner's level of knowledge of various aspects of a given word, or how well the learner knows this word. The depth of vocabulary knowledge means more than knowing the meaning of a word in a context. This ranges from the knowledge related to its pronunciation, spelling and register to how it relates to other words (Nassaji, 2004; Read, 2000).

2.10.2 Current experiences in vocabulary knowledge

Comprehension is related to the depth and breadth of vocabulary knowledge of the learner (Qian, 2002). It has been reported by researchers that there is positive correlation between vocabulary knowledge and comprehension (Qian, 1999, 2002; Nagy, 2001). Comprehension is said to have linked to conceptual understanding in technical areas like computer science (Ulijn & Strother, 1990). Is there a link between vocabulary knowledge and conceptual understanding in areas like mathematics? The underlying reason is that mathematics has numerical and abstract concepts represented most often by words. Vacca and Vacca (1996) explain that a word can present a concept which carries meaning that is more than that single word. The meaning of the concept may be explained by using more than one word in the ordinary language. In mathematics there are "more concepts per word, per sentence and per paragraph than any other area" (Schell, 1982, p 544). For example, to calculate the area of a two dimensional shape, one has to link certain mathematical ideas and words together. Firstly, one has to identify the shape, its dimensions and measurement and relate this to the right mathematical formula to calculate the shape. Nevertheless, this mathematical concept is explained using the everyday language with different meanings applied only in mathematics. Therefore a greater level of vocabulary and syntactic knowledge is essential for a learner to understand the single concept represented in the words of word problems.

To learn to properly solve mathematical word problems, students need to develop deeper and wider vocabulary knowledge (Barwell, 2005). Evidence from several scholars (Qian, 1998, 1999, 2002; Qian & Schedl, 2004; Shiotsu & Weir, 2007) showed that vocabulary knowledge is essential for the comprehension of texts. Having said this, Martiniello (2008) similarly maintains that vocabulary knowledge is a predictor of comprehension of text or word problems for both English language learners and non-English language learners. Studies by Qian (1999, 2002) recorded a correlation between the size of vocabulary knowledge and reading comprehension. He maintains that depth of vocabulary knowledge contributes more to comprehension than vocabulary size. Words that are learnt at an earlier stage are likely to have more depth than words that are recently acquired (Qian 2002).

Zhang and Anual (2008) found similar results when conducting a study of 37 Singaporean secondary school students. In this study, the objectives were to create a correlation between vocabulary size and reading comprehension and the impact vocabulary difficulty have on comprehension. They recorded that there was a significant correlation between vocabulary knowledge and comprehension as measured by students' performance in the vocabulary levels test and comprehension test. However, the study by Zhang and Anual (2008) did not measure the size of mathematical vocabulary knowledge with comprehension of word problems solving.

Montague et al (2008) suggest that vocabulary knowledge level directly affects the conceptual understanding of students in mathematics. They state that there is a direct link to comprehension of word problems and performance in tests. This suggestion was made after a study of vocabulary-dense word problems was conducted on 320 low and average middle school students of Florida in the United States. In this study, the majority of students indicated poor knowledge of the mathematics vocabulary and the conceptual understanding that were needed for solving word problems. It will be interesting to measure the words a student understands in a word problem in relation to the context that the words are used in mathematical word problems. An assessment that has been widely used to measure the size of vocabulary knowledge is the vocabulary levels test (Nation, 1990, 1993).

2.10.3 Syntactic knowledge

As far as the comprehension of a mathematical word problem is concerned, syntactical knowledge also plays an important role. It is therefore important for learners of mathematics and problem solvers to develop greater syntactical knowledge as well as having sound vocabulary knowledge (Martiniello, 2008). Syntactical knowledge encompasses the understanding of the well-formedness or ill-formedness of a sentence or subparts of a sentence such as a clause or a phrase (Crystal, 1987; Richards et al; 1992; Sampson, 1975; Shiotsu & Weir, 2007). Understanding the position of the word and its relationship with other words can help in determining the meaning in the text. Greater syntactical knowledge leads to successful comprehension, which is an important step in problem solving in mathematics (Qian, 1999).

2.10.4 Previous studies in syntactic knowledge

Many studies conducted in the area of syntactic knowledge and mathematical learning have shown a link between complex syntactical structure and low performance in word problems (Abedi & Lord, 2001; Larsen, Parker & Trenholme, 1978; Leach & Bowling, 2000; Martiniello, 2006; Wheeler & McNutt, 1983; Shaftel, Belton-Kocher, Galssnap & Poggio, 2006; Ulijn & Strother, 1990). These studies have presented interesting and contradictory findings.

For example, Ulijn and Strother (1990) found that syntactical complexity did not affect the level of comprehension of texts than vocabulary knowledge. Their empirical study showed that complexity of syntax does not significantly affect the level of reading comprehension. This suggests that whilst a complete conceptual and lexical understanding may be necessary for reading comprehension, syntax does not affect comprehension of the text. However, is this true for subject like mathematics?

In another context, Japan, Shiotsu and Weir (2007) in their study of about 600 university students found that syntactic knowledge was a better predictor of text comprehension than vocabulary knowledge. Although this study was not done on mathematical word problems, there is a suggestion that syntactical knowledge is presumed to be a predictor to comprehension of word problems as well. It will be interesting to explore the impact of syntactical knowledge on comprehension and solving of word problems. However, findings from Abedi and Lord (2001) revealed that difficulty in text comprehension by English language learners was due to syntactical complexity. Even when students know the vocabulary and computation required, the organisation of words prevents them from fully understanding the problem (Leach & Bowling, 2000; Wheeler & McNutt, 1983). Complex sentences, phrases and verbs are difficult for students (Latu, 2005; Leach & Bowling, 2000; Shaftel et al, 2006).

Similarly, Martiniello (2006) found evidence that difficulties were associated with syntactical features. Long phrases, prepositional nouns, or a noun phrase like *even number* led to difficulty in comprehension. This has appeared to have deepened the difficulty in understanding the mathematical meaning of a word problem (Martiniello, 2006). Wheeler and McNutt (2001), who conducted a study on 30 eighth grade students enrolled in remedial classes found syntactical complexities of mathematical word problems created difficulty in solving for low ability students, although the word problems were within their reading and vocabulary levels. This study, however, focused only on students who needed remedial work and did not specifically define the level of English proficiency level. Possibly research of such a nature can be conducted in the Solomon Islands relating to syntax and word problems in year eight students who are English language learning students.

Larsen et al (1978) similarly found that in word problems difficulty is associated with the syntactical complexity of the problems. Their study of 45 year eight students in the United States recorded that syntactical complexity of the sentences influenced the performance of students. Though the sample was relatively small the result showed that there was poor performance by students in word problems due to syntactical complexity. Interestingly the study suggested that as the complexity of the word problem intensifies the performance of the students in solving word problems declines. A sample of a complex sentence is as follows:

> Mary walked 18 blocks from school to the library and then walked home. If she walked a total of 56 blocks, how many blocks is it from the library to her home?

These studies showed that the interaction between language and mathematics is real. The reality is that there are some places where learners are having problems in mathematics because of their language background. Underlying this is the fact that greater linguistic complexity increased the difficulty of mathematical word problems, especially for English language learners.

2.11 Summary

Learning mathematics is like learning a new and foreign language for English language learners. Mathematics language is constructed from both everyday language and language of a highly specific and technical form. It has a register that contains a large range of terms collected and borrowed from the natural language and from other languages. Additionally, it is constructed of symbols and other non-verbal images. Language plays an important role in learning and understanding of mathematical concepts. These characteristics of mathematics language present a challenge for Solomon Islands students. The challenge is for students to understand the mathematical meanings behind the concepts.

Research shows that the level of proficiency contributes to the increasing and deepening of understanding and solution of mathematical word problems. There is still a need to identify the level of English proficiency existing amongst Solomon Islands students. It is also important to find out to what extent it influences mathematics understanding. More specifically, it is worth exploring the level of proficiency in mathematical English language and the understanding and solving of word problems. The word problems used in this research provoked the participants to think and analyse in order to select the suitable procedure for finding the solution. Almost all mathematical word problems in this research contained features that present too much or too little data in order to stimulate the students to think deeply about the linguistic features of the word problems. Research shows that difficulties with mathematical word problems tend to occur in areas of mathematical vocabulary, syntactical complexity and comprehension. These difficulties impact on strategies used by students in understanding and solving mathematical word problems.

2.12 Gaps in literature

There is clearly a need to conduct a study in the Solomon Islands regarding language and word problem solving because a gap exists in the areas of knowledge about vocabulary, syntax and the role of language proficiency in comprehension of word problems.

Little research exists about students' perceptions of the difficulties particularly in Melanesia. Hence, it is interesting to carry out a similar study in this area in the Solomon Islands regarding the perceptions of the difficulties associated with word problems for Solomon Islands students.

Thus this study focuses on examining the impact on these students of language proficiency and linguistic features like syntax and vocabulary in comprehension and solving of word problems. The next chapter outlines the research methodology utilized in this research.

CHAPTER THREE: RESEARCH METHODOLOGY

3.0 Introduction

To address the gaps identified in the literature, a study was conducted in the Solomon Islands. This explored linguistic challenges and the role of language proficiency in students' comprehension and solving of mathematical word problems. A mixed-method approach for data collection was used to elicit information to address the following research questions:

1. What are the influences of English language proficiency in solving of word problems in secondary schools classrooms of the Solomon Islands?
2. How does difficulty in linguistic features like vocabulary, phrases and syntactical features cause difficulties in comprehension and solving of mathematical word problems?
3. What are the students' perceptions of the sources of difficulty for solving mathematics word problems?

This chapter presents the methodological framework used in this research. It begins by defining the mixed-method framework used, and then explains its strengths. Next, the data collection methods are described. These included a language and mathematical assessment portfolio and semi-structured recall interview. Following sections describe the procedure for selection of participants, the sample size, procedures for data collection and ethical consideration. The process used for data analysis and transcription is also described and validity and inter-rater agreement are mentioned.

3.1 The mixed-method approach

The methodological framework for this research adopted the mixed-method approach for data collection. In order to study the actions, situations and consequences, in the context of the Solomon Islands, I used research methods influenced both by quantitative and qualitative paradigms (Cohen Manion & Morrison, 2000, 2007; Onwegbuzie, 2000). The mixed-method approach unites quantitative and qualitative techniques, methods, approaches, concepts and language into a single study

(Creswell & Clark, 2008; Johnson & Onwegbuzie, 2004). This dual approach of data collection provides a better understanding of any situation. In this research, there was an integration of both methods by way of language and mathematical assessment portfolios and a semi-structured recall interview. This is a means of incorporating knowledge from the experiences of year 8 students in the context of the Solomon Islands.

3.2 Strengths of the mixed-method approach

The mixed-method approach was chosen in this research for some of its strengths. The mixed-method is complementary as well as a source of triangulation. Firstly, the mixed-method proves to provide stronger evidence of any situation for which studies are undertaken. Greene, Caracelli and Graham (1989) view the results of mixed-method approach as complementary because the mixed-method approaches overlap and obtain different views of the same phenomenon. Mixed-method is a way of reducing the limitations associated with using a single method (Sechrest & Sidani, 1995).

The second strength of mixed methods is in triangulation. Triangulation is the use of more than one research method of collecting data (Cohen Manion & Morrison, 2007; Onwuegbuzie, 2002). Triangulation is referred to as the use of multi methods to offset biases in investigation of the same phenomenon (Creswell & Clark, 2008; Richard & Morse 2007). The purpose of triangulation is to develop a deeper understanding of the happenings and provide richer data of the same phenomenon through the use of different methods (Rossman & Wilson, 1985). Accordingly this research used the qualitative approach of semi-structured recall interview and quantitative data collected from the language and mathematical and assessment portfolios. The use of triangulation in research enhances greater confidence in the researcher about the results (Jick, 1979). Confidence is high in this research as the results were measured quantitatively from performance in the language and mathematical assessment portfolios and underlying perceptions of the difficulties were drawn from the semi-structured recall interviews conducted later.

3.3 Data collection methods

Creswell (2003) points out that a major element of any research approach is the specific methods used to collect data. The specific methods used for data collection in this research were language and mathematical assessment portfolios and a semi-structured recall interview. These were applied in sequential triangulation (Morse, 1991). The data collection process was divided into two phases. In the first phase, a quantitative study of the language and mathematical assessment portfolios was conducted. This was followed by the qualitative method of a semi-structured recall interview. Below are the details of the data collection methods used.

3.3.1 The language and mathematical assessment portfolios

The tools making up the language and mathematical assessment portfolios included an English proficiency exercise, a vocabulary levels test and a mathematical word problem exercise.

The English proficiency exercise involved a short essay on the advantages and disadvantages of the wantok system. This was done during English classes. The topic of the wantok system was chosen as all students have had experience of this phenomenon and are well versed to it. It was expected that students would not find it too difficult to write an essay about this topic.

The vocabulary levels test has been used by Nation (1983) to measure the size of vocabulary knowledge. It is usually done by measuring the meanings of words for different frequency levels (Read, 2000). The frequency levels range from 1000 word level to 10,000 word levels, where 1000 word level is the high frequency level and 10,000 word levels is the low frequency word level. It had been claimed by various researchers like Laufer and Paribakhti (1998) and Qian (1999) that the vocabulary levels test is widely accepted for the purpose of measuring the vocabulary knowledge of non-English speakers. For this reason, a similar vocabulary levels test was used in this research. The vocabulary levels test was used to determine the link between vocabulary knowledge and comprehension of mathematical word problems.

Additionally, a set of mathematical word problems was employed in this research to gather information about the students' comprehension and solving of word problems. Thus, the word problems are believed to elicit valid data (Cohen et al., 2007). Fourteen mathematical word problems used in this research (see Table 1). These word problems used were designed in consultation with a Solomon Islands mathematics specialist. The word problems were partially selected from the current topics under the Solomon Islands mathematics syllabus (Ministry of Education, 1997). A few items were adopted and modified from the assessment tool of Numeracy Development Project under the Diagnostic Interview (New Zealand Ministry of Education, 2008). The changes to those word problem adopted were done to suit the context of the Solomon Islands.

These mathematical word problems range from a one step solution process to a more complex and lengthy nature. The fourteen word problems were rated from easy to difficult. The word problems contained mathematical concepts embedded in linguistics features. The mathematical word problems included the four mathematical operations (x, +,-, ÷), the concept of average and uniform speed, sharing of quantities amongst people, comparison and fractions (see Table 1). The sentences ranged from simple to complex sentences with an interrogative sentence. The easy items included both a simple and an interrogative sentence. The moderately difficult word problems consisted of one simple sentence, one complex sentence and an interrogative sentence. The difficult word problems contain compound and complex sentences. Compound sentences contain two sentences joined by conjunctions. A complex sentence contains a dependent and independent clauses (see Table 2). In this research the word problems also contained mathematical vocabulary and phrases as well. The vocabulary level for all the word problems was believed to be within the breadth and depth of year 8 Solomon Islands students.

Table 1.
The word problems rated according to mathematical criteria

Word problems	Criteria for rating	Rating
Tom had got 35 marbles and gave 9 of them to his sister Ann. How many marbles had Tom got left?	Simple subtraction	Easy
Fifty three people got on a bus at King George and travelled to Point Cruz. Twenty-six people got off at Lawson Tama and half this amount got off at Point Cruz. How many people were left on the bus?	Subtraction and multiplication and fraction	Difficult
Desmond has 390 stamps. He gets another 90 stamps from his brother. His little sister asked him if she could be given 100 stamps for her school work. How many stamps does he have then?	Simple two step subtraction and addition	Easy
A car moving at a uniform speed travels 32 kilometres in 0.5 hours. What is the speed of the car? Express your answer in kilometres per hour.	Speed involving division and the idea of ratio converting of solution to kilometres per hour	Difficult
A number is multiplied by six and the answer is 36. What is that number?	Division and multiplication	Moderate
A number is subtracted from 60 and the answer is 24. Find the unknown number?	Algebraic equation involving subtraction	Difficult
There are 27 coconuts to be shared between two brothers Peter and Belo. One of the brothers, Belo got seven coconuts. Peter then divided his share with his friend who got one quarter of the remaining coconuts. How many coconuts will Peter have left?	Subtraction and sharing of quantities amongst people and fraction	Difficult
Mary is fourteen years old. John is one and a half times older than her. How old is John?	Comparison of ages of two people, multiplication	Difficult
A girl walks at an average speed of 2 kilometres per hour. If she walked ten kilometres in one day, how many hours would she have walked?	Concept of speed, multiplication to find distance	Moderate
Anna went shopping at Kazu store. She had $100-00 and bought the following items: two cans of tuna at $10 each, three packets of noodles at $3 each and one packet of milk tea at $2 and one half kilogram of sugar at $4. How much money would be her change from the $100?	Basic addition, multiplication and subtraction concerning change	Easy
A number multiplied by itself gives one quarter of one hundred. What is the number?	Fraction, multiplication and square root	Moderate
Bill adds two numbers together. His first number is negative seven and his second number is positive five. What will be his answer?	Directed numbers, addition and subtraction	Moderate
Ford and May shared one hundred dollars. If Ford gets three quarters of the amount, how much would May get?	Sharing, multiplication and subtraction	Difficult
Tom and Paul shared a cake. Tom ate ¼ and Paul ate⅛. How much of the cake was left?	Fraction, multiplication, addition and subtraction	Difficult

Table 2.
The word problems rated according to linguistic criteria.

Word problems	Criteria for rating	Rating
Tom had got 35 marbles and gave 9 of them to his sister Ann. How many marbles had Tom got left?	One simple sentence. One interrogative question.	Easy
Fifty three people got on a bus at King George and travelled to Point Cruz. Twenty-six people got off at Lawson Tama and half this amount got off at Point Cruz. How many people were left on the bus?	One simple sentence. One complex sentence. One interrogative sentence.	Difficult
Desmond has 390 stamps. He gets another 90 stamps from his brother. His little sister asked him if she could be given 100 stamps for her school work. How many stamps does he have then?	Two simple sentences. One interrogative sentence.	Easy
A car moving at a uniform speed travels 32 kilometres in 0.5 hours. What is the speed of the car? Express your answer in kilometres per hour.	One simple sentence with mathematical terms. One interrogative sentence. One complex sentence.	Difficult
A number is multiplied by six and the answer is 36. What is that number?	One complex sentence. One interrogative sentence.	Moderate
A number is subtracted from 60 and the answer is 24. Find the unknown number?	One complex sentence. One interrogative sentence.	Difficult
There are 27 coconuts to be shared between two brothers Peter and Belo. One of the brothers, Belo got seven coconuts. Peter then divided his share with his friend who got one quarter of the remaining coconuts. How many coconuts will Peter have left?	Two compound sentences. One interrogative sentence.	Difficult
Mary is fourteen years old. John is one and a half times older than her. How old is John?	One complex sentence. One interrogative sentence.	Difficult
A girl walks at an average speed of 2 kilometres per hour. If she walked ten kilometres in one day, how many hours would she have walked?	Two complex sentences.	Moderate
Anna went shopping at Kazu store. She had $100-00 and bought the following items: two cans of tuna at $10 each, three packets of noodles at $3 each and one packet of milk tea at $2 and one half kilogram of sugar at $4. How much money would be her change from the $100?	Two long simple sentences. One interrogative sentence.	Easy
A number multiplied by itself gives one quarter of one hundred. What is the number?	One complex sentence. One interrogative sentence.	Moderate
Bill adds two numbers together. His first number is negative seven and his second number is positive five. What will be his answer?	One simple sentence. One complex sentence. One interrogative sentence.	Moderate
Ford and May shared one hundred dollars. If Ford gets three quarters of the amount, how much would May get?	One simple sentence. One compound sentence.	Difficult
Tom and Paul shared a cake. Tom ate ¼ and Paul ate⅛. How much of the cake was left?	One simple sentence. One interrogative sentence.	Difficult

3.3.2 The semi-structured recall interview

The other method for collecting data was a semi-structured recall interview. A semi-structured interview is a relatively informal, relaxed discussion based around a predetermined topic (García-Vila, Lorite, Soriano, & Fereres, 2008). Hancock (2002) explains that the semi-structured interview has an open ended nature and provides opportunity for both the interviewer and interviewee to discuss the topic in detail. With the exchange of ideas and thought, new knowledge is created. This form of interview tries to minimise the hierarchical situation in order that the subject feels comfortable talking with the interviewer. The underlying objective is to capture as much as possible of the subject's thinking, feeling and experiences about a particular topic.

A semi-structured interview is usually carried out in a face-to-face way. However, in the Solomon Islands context, a side by side format indicates respect towards the participants, as it is unacceptable in some cultures of the Solomon Islands to make eye contact whilst sharing. The semi-structured recall interview was conducted only with eight of the 45 participants selected for this research and was implemented in only two of the three schools. The predetermined topic of this research was the perceptions of the eight participants regarding the difficulties they faced in the mathematical word problems exercise. During the process, new questions were raised on the issues of the first answers given by the subjects.

3.4 Sites for data collection

I visited three schools to carry out my data collection. These are referred to as schools A, B and C. Brief descriptions of the three schools are given below.

School A is located in the eastern part of Honiara city. This school is co-educational but classes are separated in terms of gender. There were fifteen female participants for the language and mathematical assessment portfolio. Four were later selected by their teachers from this cohort to participate in the semi-structured recall interview. These were all from the Solomon Islands with only one being part Asian. Therefore all of them spoke English as their second or third language. This school was owned and administered by the Church of Melanesia Education Authority. The school provides education from kindergarten up to Form seven. The population of the school to date is over one thousand. The school is a strong advocate of gender equity in education. It is part of the school policy to separate classes according to males and females because this practice opens more opportunities for female students who are always under-represented. The students who attend this school represent a mixture of linguistic and economic backgrounds. Most of them come from parents who hold very high positions in the church, government and the private sector.

School B is a school in the mid-western end of Honiara city. This school used to be owned and administered by the Catholic Mission and it is now governed by the City Council. Most of the students come from other provinces and so speak a combination of the lingua franca and their local vernacular. The school includes secondary primary and kindergarten sectors. It has a population of about one thousand students. The children attending this school have parents with a range of incomes. There were fifteen students participating in the language and mathematical assessment portfolio. These comprised nine male and six female students between 13 and 17 years old.

School C is located in the centre of Honiara city. It is a co-educational school that has over five hundred students. The majority of the students attending this school are from the nearby squatter settlements. Fifteen participants from this school participated in the language and mathematical assessment portfolio. There were seven males and eight females of both Polynesian and Melanesian descents. Four were then selected for the semi-structured recall interview. Most of these come from families that have low socio-economic status. The parents of these students are mostly market vendors and other low income earners. Furthermore, most of these students usually communicate in their common vernacular and pidgin. The only occasion that English is used is during English lessons and when required for English tasks.

3.5 Procedures used for selecting participants

For this research project, the study focussed on three classes of year eight students from three secondary schools located in Honiara. The students were selected by their teachers based on their achievements in both English and mathematics in the previous terms. These students were categorised by their teachers as high achievers in English and mathematics, average achievers in English and mathematics and low achievers in these two subjects.

3.6 Sample size

The size of the sample was determined prior to the data collection for the language and mathematical baseline portfolio and the recall interview. There were 45 participants (20 males and 25 females) chosen altogether for the language and mathematical assessment portfolios and eight were selected for the semi-structured recall interview. The sampling method is described as purposive sampling (Cohen & Manion, 1985). I approached the principals and the teachers responsible to provide the potential participants for this research. The participants were between 14 and 17 years with more than fifty percent of the participants above 15 years.

3.7 Procedures for collecting data

Data were collected during three different sessions over a period of approximately six weeks. The first session involved the task on the proficiency level of the students in English. This was conducted in the English lesson of the schools. The session ran for forty minutes, the normal duration of each class lesson in the Solomon Islands. The second session was on the vocabulary levels test. The third session was conducted on the mathematical word problems exercise. Worksheets containing the problems were distributed. The students were given five minutes to read through and ask any questions about the tasks.

Eight participants were selected from two schools (schools A and C) to participate in the semi-structured recall interview. The selection of these eight students was made by their teachers from the original fifteen that participated in the language and mathematical assessment portfolios. The intention of the semi-structured recall interview was to probe into their views regarding how they performed in solving the word problem exercise delivered earlier. Questions were designed to have strong links to the outcomes gathered in the word problem exercise, the proficiency exercise and the vocabulary levels test.

3.8 Ethical consideration

Prior starting my research in the Solomon Islands, I sought ethics approval from the University of Waikato, Faculty of Education Ethics Committee. The Ministry of Education and Human Resources Development in the Solomon Islands was another stakeholder whose permission was sought. Permission to carry out the research was also sought from the Permanent Secretary (See Appendix 1).

Before I entered the schools, consent was obtained from their principals, by way of their signing a consent letter given to them prior to a meeting of the teachers and students (See Appendix 2). After permission was granted by the principals, the participants were selected by their respective subject teachers of mathematics and English. These students were provided with consent letters for their parents (See Appendix 3 and 4). The consent letters contained relevant information regarding the whole study and other ethical considerations.

3.9 Data Analysis

In this research, analysis was done on the data collected from the language and mathematical assessment portfolios and the semi-structured recall interviews. The data analysis involved transcription of the semi-structured recall interview and analysing the texts from the essay component of the language and mathematical assessment portfolios.

3.9.1 Data transcription

All the eight interviews were conducted in pidgin and were audio-recorded and transcribed. Interviewing in pidgin was appropriate as it allowed the students to express their views more clearly. The transcribed responses of the students during the semi-structured recall interviews were classified under themes for further analysis. Thematising the findings is a common process in qualitative studies (Cohen et al, 2007). In this research, the common occurrences were placed under themes and then compared with the literature. I coded participants' contributions using letters and numerals. For example an utterance is coded AM1. The first letter indicates the first school, the second letter indicates the gender and the numeral shows the order of the participants.

3.9.2 Text Analysis

A writing rating scale was adopted from Hawkey and Barker (2004) to assess the quality of the written texts of the participants (see Appendix 8). This was used in place of the T-unit analysis established by Hunt (1965) and Structural Analysis of Written Language (SAWL) (White, 2007). The reason was that the majority of the participants demonstrated numerous grammatical errors and this made it difficult to identify clauses. The rubrics adopted consisted of a fixed measurement scale and a set of criteria used to assess the writing level demonstrated by the participants. Moskal and Leydens (2000) maintain that rubrics respond to the concerns of subjectivity and unfairness by creating a formal means of scoring the process and product of students.

3.10 Validity

This research adopted the mixed-method approach to gathering data from the participants. Nevertheless, most of the data concerned the perceptions of participants regarding the difficulties that they had experienced during the process of comprehension and solving of word problems. Hence, there was the challenge of validating the data. There are also a lot different types of validity (Cohen et al, 2000, 2007). The concept of validity is the measure of truthfulness of the data collected (Altheide & Johnson, 1994; Joppe, 2000; Whittemore, Chase & Mandle, 2001). To measure the truthfulness of the data I asked the participants to verify what they said in the recalled interview immediately after each interview session. In this way, the data collected were verified and had met what the study was supposed to have measured (Cohen et al, 2000). Validity is also measured through triangulation (Golafshani, 2003; Joppe, 2000). In this research it was achieved through the data collected from the language and mathematical assessment portfolios and semi-structured recall interviews.

3.11 Inter-rater agreement

Inter-rater agreement is the extent to which two or more individual coders or raters agree. This addresses the consistency of the implementation of a rating system. In this study it was applied when scoring the participants' writing tasks. Stemler (2004) upholds three types of inter-rater reliability: consensus estimates, consistency estimates and measured estimates. In this research, consensus estimates were used to analyse the participants' written responses. Stemler (2004) maintains that consensus estimates are based on assumptions that observers are able to reach an agreement on how to apply levels of scoring rubrics to the responses of participants. Hence, in rating the scores for the writing task in this research, an agreement regarding the levels of performance was reached by two judges, one of them being the researcher. Consensus agreement was reached after discussing the responses of the participants in the writing test. There was rater reliability of almost 80%.

3.12 Summary

This chapter has discussed the mixed-method approach of data collection to address the gap identified in the literature. The strengths of the mixed method approach and the types of data collection method were examined and the sites for data collection, procedures for selection of participants and collection of data were described. The chapter also included research ethics, data analysis and the issues of validity and inter-rater agreement. The next chapter deals with the findings of this study.

CHAPTER 4: RESEARCH FINDINGS

4.0 Introduction

This chapter presents the data obtained during the data collection. During the data collection, results were obtained from the language and mathematical assessment portfolios and a semi-structured recall interview. The language and mathematical assessment portfolios were done to address the following research questions:

1. What are the influences of English proficiency in solving of word problems in secondary classrooms of Solomon Islands?
2. How does difficulty in linguistic features like vocabulary, phrases and syntactical features cause difficulties in comprehension and solving of mathematical word problems?

I had also designed semi-structured recall interview questions (see Appendix 8) which I asked eight participants after the mathematical word problems exercise. The objective was to get information to address the third research question:

3. What are the students' perceptions of the sources of difficulty for students in comprehending and solving the mathematics word problems?

This chapter discusses the evidence gathered from the students. Specifically it begins with the perceptions of the students and how they rated each of the word problems. Next, I compiled data from the mathematical word problem exercise together with student perceptions as gathered from the semi-structured recall interview. This was to investigate their reasons for obtaining the solutions in the word problems. The purpose was to consolidate and synthesise the data and to provide a description of the situation in the three schools where the data were collected.

Table 3.
My ratings and the participants' ratings on each word problem

Word problems	My ratings	Participants' rating
Tom has got 35 marbles and given 9 of them to his sister Ann. How many marbles had Tom got left?	Easy	Easy
Fifty three people got on a bus at King George and travelled to Point Cruz. Twenty-six people got off at Lawson Tama and half this amount got off at Point Cruz. How many people were left on the bus?	Difficult	Very Difficult
Desmond has 390 stamps. He gets another 90 stamps from his brother. His little sister asked him if she could be given 100 stamps for her school work. How many stamps does he have then?	Easy	Easy
A car moving at a uniform speed travels 32 kilometres in 0.5 hours. What is the speed of the car? Express your answer in kilometres per hour.	Difficult	Difficult
A number is multiplied by six and the answer is 36. What is that number?	Moderate	Moderate
A number is subtracted from 60 and the answer is 24. Find the unknown number.	Difficult	Difficult
There are 27 coconuts to be shared between two brothers, Peter and Belo. One of the brothers, Belo, got seven coconuts. Peter then divided his share with his friend who got one quarter of the remaining coconuts. How many coconuts will Peter have left?	Difficult	Difficult
Mary is 14 years old. John is one and half times older than her. How old is John?	Difficult	Difficult
A girl walks at an average speed of two kilometres per hour. If she walked ten kilometres in one day, how many hours would she have walked?	Moderate	Moderate
Anna went shopping at Kazu store. She had $100.00 and bought the following items: two cans of tuna at $10 each, three packets of noodles at $3 each, one packet of milk tea at $2 and one half kilogram of sugar at $4. How much money would be her change from the $100.00?	Easy	Easy
A number multiplied by itself gives one quarter of one hundred. What is the number?	Moderate	Moderate
Bill adds two numbers together. His first number is negative seven and his second number is positive five. What will be his answer?	Moderate	Moderate
Ford and May shared one hundred dollars. If Ford gets three quarters of the amount, how much would May get?	Difficult	Difficult
Tom and Paul shared a cake. Tom ate ¼ and Paul ate⅛. How much of the cake was left?	Difficult	Very Difficult

4.1 Students' perceptions of the difficulty of the word problems

The perceptions of the students included the way they rated the difficulty of each word problem according to both linguistic and mathematical features on scale of easy, moderate, difficult and very difficult (see Tables 1 and 2). The findings regarding the ratings are presented in Table 3.

This information includes my original ratings prior to data collection and the participants' ratings on each word problem. It is interesting to observe that the participants' ratings for each of the word problems vary slightly. Although the students' ratings were very close to my ratings on most of the word problems there were great differences amongst them in terms of the correct solutions for each problem. This is clearly observed in the different frequency and percentages of correct solutions in each category for each problem. It was interesting to note that the participants rated two of the fourteen word problems as very difficult. Two of these were initially rated as difficult.

The results are organised according to the level of ratings and frequency and percentage of correct solution for each problem in each category. For the semi-structured recall interview responses I use letter and numeral coding to denote the participants' contributions. The first letter indicates the site (school), the second letter tells the gender (male/female) and the numeral denotes the number of participant. The section commences with the results concerning the easy word problems followed by findings on the participants' experiences and categorisation of the word problems.

4.1.1 Word problems rated as easy by participants

Below is the table showing the percentage and the number of students with correct solutions to the easy word problems.

Table 4
Frequency and percentage of correct responses for word problems that were rated by the participants as easy

No.	Easy word problems ranked in difficulty	Frequency (%)
1	Tom has got 35 marbles, and given 9 of them to his sister Ann. How many marbles had Tom got left?	45 (100)
2	Desmond has 390 stamps. He gets another 90 stamps from his brother. His little sister asked him if she could be given 100 stamps for her school work. How many stamps does he have then?	40 (89)
3	Anna went shopping at Kazu store. She had $100.00 and bought the following items; two cans of tuna at $10 each, three packets of noodles at $3 each and one packet of milk tea at $2 and one half kilogram of sugar at $4. How much money would be her change from the $100.00?	30 (67)

Out of the fourteen word problems, the participants rated three of them as easy. Although all participants rated these three as easy, there were differences in the frequency and percentage of the correct solutions to these word problems (see Table 4). These word problems were centred on operations of addition, subtraction and multiplication and involved the concept of change. Linguistically, these word problems contained simple sentences with each having an interrogative sentence that contained the statement for the calculation of the unknown quantity.

It is interesting to observe that all 45 students had correctly solved word problem one (see Table 4). For word problem one which was the easiest of all, participants easily understood and explained it in another way. This was reflected in the response of the following student:

> *Okay um, Tom has got 35 marbles and given 9 to his sister and so I take away 9 from 35. The word*

> *problem is short and easy to understand and it is just involving subtraction.* (AF2)

This participant could easily identify this word problem as short and involving change. The shortness of this word problem helps this student to identify the main operation of subtraction and find the correct solution.

Similarly, the view that the word problem is short is shared by another participant:

> *The question is mainly is little bit easy because it mainly talks about minus [subtraction]. The question is quite short. The understanding of this question is about subtraction. (*CM2)

This statement reflects understanding of the size and operation. The shortness of the word problem, made it quite easy for the participant to identify the arithmetic operation required to find the correct solution. Another participant reinforced the easiness of this word problem due to its shortness:

> *When it is short, if I read and easily understand, it is easy to work out and get to the answer*. (CF2)

This participant claimed that the shortness contributed to a better understanding of the word problem. This shortness contributed to better comprehension and easy solution. The shortness of the word problem was also noted by another participant:

> *This word problem is short and can easily be understood and it is just straightforward*. (CM3)

The above statements indicate that the size of the word problems provided no obstacles for understanding. Hence, the students had no difficulty in calculating the correct solution. The size of this particular word problem helped them to quickly understand its intention and select the correct arithmetic operation.

Another student expressed a similar experience in understanding and solving this particular word problem and also commented that the vocabulary caused no difficulty.

> *Yes, it is easy to understand and answer as when I read this question automatically I can work out the solution. The short questions can be easily followed*

> *and there are no technical or hard words that might create difficulty.* (CM4)

Another participant made a similar statement:

> *The question is short and it is like, Tom has 35 marbles then given 9 to his sister and question asks me to get 35 take away 9 and got the answer*. (AF3)

An interesting perception shared by the participants concerning this particular word problem was that it was short and the language used was not too difficult to comprehend. This led them to correctly solve this particular word problem.

Another easy word problem that yielded a large number of correct solutions is word problem two (see Table 4). Arithmetically it is similar to word problem one and involved steps of addition and subtraction. However, the word problem was long but was not seen particularly difficult to the majority of the participants. There were different perceptions regarding comprehension of this particular word problem. The following are some the remarks regarding this word problem:

> *The question is straightforward and so I managed to answer the question. There is nothing difficult about the question.* (AF1)
>
> *Though word problem two is long but I could easily follow this question and there is not much as it is just basically addition and subtraction. There is not much to cause confusion for me as a student*. (CM3)
>
> *Yes.... it's that the word is stamp, then 390 and take 90,another 100 and give away another 100.That is subtraction and addition in one calculation.* (CM1)
>
> *There were no difficult words in this word problem. So I just add the 90 and get 480 the answer and take way 100 from the answer and that gives me the answer.* (CM3)

Although this word problem is longer than word problem one (see Table 4 for comparison), the statements from the participants show that they have understood and connected the sentences together and understood its intention. The above statements indicate that students can interpret the mathematical meaning of a statement in a long but easily rated word problem as in this particular problem. This interpretation resulted in them correctly finding the right mathematical solution. The statements also show that the vocabulary used in the word problem was not very difficult for them and did not prevent them from understanding and calculating the correct solution.

An interesting finding was also recorded regarding the solutions for word problem three (see Table 4). The participants also rated this word problem as easy because it was a typical situation involving the basic items that are always bought in the canteens and shops of Honiara. However, it was interesting to know from this research that only 30 of 45 the participants correctly solved it. One of the participants said:

> *I know how to add and subtract alright. I just add the cost of tuna, noodles, milk tea and sugar and get the answer. I subtract the total cost from the $100 to get the change and that is the final answer.* (AF2).

Although this word problem also involved the operation of multiplication in the process of solving, this statement shows that this participant used the additive strategy to calculate the total costs of *2 cans of tuna* and *3 packets of noodles*. Additive strategy involved applying repeated addition to a multiplication situation. However, this participant understood the main intention of the word problem and calculated the correct change from the initial quantity of $100.00. A similar response was obtained from another participant who stated:

> *I just plus every item bought and subtracted the total from the $100.This is because there was no hard word in this word problem to make it difficult for me. I understand this word problem as it only deals with addition and subtraction.* (AF4)

This participant also repeatedly added the cost of tuna and noodles before combining these with the other items in the word problem and got the total cost of the purchase. Later on there was subtraction applied in order to get the change from the 100 dollars. This participant saw this word problem as not containing difficult vocabulary that might hinder the understanding. This participant considered this word problem as only requiring addition and subtraction and overlooked the need for multiplication in the process of solving for the solution.

Another participant claimed to have similar yet deeper understanding of this same word problem. This was reflected in the explanation of the process that she had employed to obtain the right solution. This participant was more familiar with the word problem which helped her to understand it:

> *Yes I can relate to this question with the words like cans of tuna, shopping and noodles. Also I added the two cans of tuna like 10 dollars for one so I multiplied 10 by 2, keep its answer, then three packets of noodles that is multiply by three and add the total. After adding the total, I subtracted it from the $100 to get the change.* (CF2)

This explanation reveals that using objects that are familiar to students in the word problems helps in solving the word problem. This participant has responded with more details regarding the little steps involved in obtaining the solution. The participant identified that multiplication was a major part of the process to get to the correct solution. This shows different levels of comprehension of the same word problems from participants in the same year level in two different secondary schools. It would be interesting to interview participants from the second school (school B). For the same word problem another participant said:

> *This word problem is long but also straightforward to answer because I am familiar with the words like tuna, noodles and shopping.* (AF1)

This statement shows a student that connects to the words in the word problem, although there is no mention of how the word problem was answered and the mathematical strategy that was used. The statement also indicates that the student did not have any difficulty with the length of the word problem.

The above perceptions of the participants reveal some important elements regarding word problems. Although some of the word problems were seen to have different lengths, certain features appeared to play a role in influencing the understanding of the word problems. I feel that features in word problem three that influenced the process of solving for the participants were the *two cans of tuna at $10 each, three packets of noodles at $3 each.* From the responses it was clear that participants interpreted the same word problem quite differently. Their understanding and interpretation influenced their choice of arithmetic operations used to solve this word problem. The difference is in the responses and that few used repeated addition to calculate the prices of tuna and noodles with one participant using multiplication to calculate the prices of the same items. However, these participants got the same final correct solution for this word problem. A connection to the situation between the solver and the word problem seemed to play a role in influencing the understanding of the word problems as well. Their real life experience helped them to relate easily to this word problem as they frequently consume these items and also know the situation very well. Thus, I was expecting a higher number of students to correctly solve this word problem. However, 15 participants did not find the correct solution and unfortunately because of time constraints none of them was able to be interviewed.

Word problems with familiar contexts were answered correctly by many participants. The students' understanding of contexts facilitated a cognitive process that contributed to the right solutions. The vocabulary used in the word problems was also easy and was easily understood by the majority of the participants. Understanding and frequent usage of the basic mathematical operations could be linked to the high outcome of performance in this research. This was revealed when comparing the percentage and frequency of correct solutions for all the word problems in the study. From the data, the word problems involving one to two steps of addition and subtraction have more correct solutions than the only word problem involving shopping which also required multiplication apart from addition and subtraction.

4.1.2 Word problems rated as moderately difficult by the participants

Four word problems were rated as moderately difficult by the participants. Although there was 100% agreement between the participants and me on the rating of these word problems, there was a great deal of difference in the responses of the participants, which I had not expected.

Table 5.
Frequency and percentage of correct solutions for word problems rated moderately difficult by participants

No	Word problems ranked in difficulty	Frequency (%)
4	A number is multiplied by six and the answer is 36. What is that number?	36 (80)
5	A girl walks at an average speed of two kilometres per hour. If she walked ten kilometres in one day, how many hours would she have walked?	23 (53)
6	A number multiplied by itself gives one quarter of one hundred. What is the number?	10 (29)
7	Bill adds two numbers together. His first number is negative seven and his second number is positive five. What will be his answer?	10 (29)

The linguistic and mathematical features of these word problems were quite different from the problems that the participants rated as easy. Word problems four, five and six involved the operations of multiplication and division, and word problem seven required the addition of positive and negative integers. Word problem four was simpler because it contained one simple sentence and an interrogative sentence but was rated moderate due to the multiplicative thinking involved. Word problems five, six and seven were rated moderate as they contained collocation and terms with specific mathematical meanings. The results show that in the four word problems rated moderately difficult over fifty percent of participants correctly solved word problems four and five (36 participants for word problem four and 23 participants for word problem five). In fact, results show that word problem four has a higher number of correct solutions than word problem three in the easy rated word problems (see Table 5). This indicates that the participants did better in word problem four than in word problem three. Whilst the majority of participants in this research could understand and solve the easier of the moderate word problems there was one participant who incorrectly solved one of them, which was word problem four. He said:

> *A number multiplied by six.....that means a number is added....and the answer is 36.* (CM2)

This indicates a total lack of understanding of the operations of addition and multiplication. It is likely that the participant confused with addition and multiplication, although when there is the term *multiplied* appeared in the word problem**.** It was interesting to find that another participant had another way of understanding this same word problem. He said:

> *Yeah word problem four is straightforward as it says that a number multiplied by 6 is 36 and that means that number is 6 as 6 times 6 is 36.That is easy to understand.* (CM3)

This shows a student who claims that this word problem is easy to solve as it only involved the facts about multiples of 6. This shows that a good knowledge of basic facts helps to quickly reach the solution to this word problem. Hence, the student has no difficulty in the understanding of items and easily interprets the requirement of this word problem. Word problem four did not have any mathematical vocabulary that could be challenging for the majority of the participants. It was a word problem involving the knowledge of multiples of six. Another perception revealed in the interview was a more complex mathematical concept of squares and square roots. A student stated:

> *When I see this word problem, I know that this question is easy as immediately I thought of the concept of square and square roots. That is two identical numbers multiplied....and gives the square [inaudible].So 6 multiply by 6 is 36 or the square root of 36 is 6.* (CF2)

It was interesting to see that participants showed different levels of knowledge and strategy use and yet arrived at the same solution. From the perceptions of these three participants, I can see that although they are in the same year level, each possesses a different conceptual understanding of the same word problem. Another participant picked on the words of the word problems in this category.

> *The words that are familiar to me are a number that is multiplied. I am also familiar with positive and negative, one quarter and three quarter* (AF1).

This statement shows a student that expresses understanding of the terms in the word problems four, six and seven. This statement also shows a student who demonstrates an understanding of words that show basic fractions like one quarter and three quarters. However, there is no explanation given to show how much the student really understands about how to get to the correct solutions. However, as we can see, the frequency of the correct solutions decreases from word problem four to word problem seven. One of the difficulties in solving word problem five was the misunderstanding of the collocation of average speed. One participant said:

I do not understand average speed. (AF3)

This statement shows a participant that has trouble in understanding this word problem when the term *average* appeared in front of the term *speed.* Without an understanding of the collocation *average speed* the participant could not solve this word problem correctly. It would be interesting to re-word this particular word problem without the term *average* and ask this participant to attempt the word problem again.

One of the aspects that created difficulty in word problem seven was perhaps the difficulty of understanding certain terms, for example, *positive* and *negative.* Perhaps the misunderstanding of these terms led some to **a** wrong solution. It was clear from the findings that only ten of the total participants responded correctly to this word problem. This misunderstanding contributed to the application of an inappropriate mathematical operation. To illustrate this, a participant said the meaning of the term negative was:

> *Yes, a number that you take away the minus is in front of the number.* (CM3)

This participant was confused between the sign of the arithmetic operation of subtraction and the meaning of a negative number. In the above statement it seemed that he was trying to illustrate that a negative number normally appeared in the operation of subtraction. This participant shows a lack of understanding of the meaning of the term negative, as does the following who explicitly stated that he did not understand the terms positive and negative:

> *I do not understand the terms like negative seven and positive five. I do not know the terms positive and negative.* (AF3)

A possible explanation for most students having problems with this question may have been infrequent usage of these terms, as stated by the following student:

> *No I don't and I have not seen the words like positive and negative quite often. This makes it hard for me to get the right answer for this word problem.* (AF4)

Twenty-nine percent of the participants, however, correctly solved this word problem. Amongst those that knew the proper meaning of the terms was a participant who said:

> *Negative number is the number on the left of the number line and they have minus in front of them and positive number is just the normal number.* (CM4)

This clearly shows a student who has no difficulty in the understanding these terms and the mathematical concepts they denote. Perhaps this student is one of the few that must have seen and used these terms in class.

The findings show that ten participants correctly solved word problem six (see Table 5). Most of those who negatively responded to this word problem associated the difficulty with a mathematical phrase. For example, one of the participants stated that in word problem 6 the statement creating difficulty was:

> *The phrase a number multiplied by itself. This phrase makes the problem quite difficult for me to understand and solve.* (AF3)

Possibly the difficult part was thinking about which number multiplies by itself to get the quarter of one hundred. Perhaps this student is cognitively slow in thinking and working out this number. Possibly this student could not connect the sentences in the word problem to get a clear picture of the intentions of the problem. Another participant had a different response.

> *What makes that word problem hard was the part that said one quarter of one hundred.* (CM3)

This student shows that it was difficult to calculate the quarter of 100. Hence, this indicates a problem in the mathematical concept regarding the fractional meaning of one quarter and relating it to another number. Another participant responded:

> *The phrase that created longer time for thinking is the number multiplied by itself. I understand the one quarter of 100 which is 25.* (CF2)

The above student indicates a student who is slow to work out the number that is multiplied by itself and is equal to one quarter of 100. This same participant was fast in thinking about the first easy word problem which involved additive strategy. However, he is slower when confronted with a word problem involving multiplication. Hence, this indicates that one of the students could think quickly additively but is slower in multiplicative thinking. However, another participant shared that:

> *Yeah, I know that one quarter of 100 is 25. The number I multiply by itself to get 25 is 5 because 5 times 5 is 25 and it is one quarter of 100.* (CM4)

This clearly indicates a student who could follow word problems and relate the important part of a word problem. This student is competent and thinks quickly in additive as well as multiplicative situations. This student demonstrated a sound mathematical knowledge and experienced no difficulty with word problems rated easy or moderately difficult.

Although these word problems were rated as moderate, it was revealed that terms with mathematical meaning contributed significantly to the students' misunderstanding. These words included *positive* and *negative*. In addition, the combination of terms in *average speed* was found to have created challenges.

4.1.3 Word problems rated as difficult by the participants

I rated six word problems as difficult. The participants rated five of the six as difficult to them. The following table shows the frequency percentage of responses to these word problems.

Table 6.
Frequency and percentage of correct solutions for word problems rated as difficult by participants

No.	Word problems ranked in difficulty	Frequency (%)
8	A number is subtracted from 60 and the answer is 24. What is the number?	31(71)
9	A car travels at a uniform speed of 32 kilometres in 0.5 hours. What is the speed of the car? Express your answer in kilometres per hour.	14(31)
10	Ford and May shared one hundred dollars. If Ford gets three quarters of the amount, how much May get?	13(29)
11	Mary is fourteen years old. John is one and half times older than her. How old is John?	12 (27)
12	There 27 coconuts to be shared between two brothers, Peter and Belo. One of the brothers, Belo, got seven coconuts. Peter then divided his share with his friend who got one quarter of the remaining coconuts. How many coconuts will Peter have left?	10 (24)

According to the list of word problems presented in Table 6, word problem eight contained an unusual order of words compared to other word problems. It was interesting to discover that although the participants rated this word problem as difficult, 31 out of 45 (or 71%) of the participants solved it correctly (see Table 6). One participant in this category stated that the order in which the words appear in this particular word problem created difficulty. This misunderstanding forced the participant to come up with this interpretation:

> *A number take away 60 and the answer is 24. That means the unknown number taken by adding 60 and 24 to get 84.* (AF2)

In this student's understanding, the unknown number was more than 60. The statement was probably misunderstood as *a number subtract 60*. In terms of mathematics, those two statements *a number subtract 60* and *a number subtracted from 60"* have different meanings. The latter implies that the unknown quantity is a number greater than sixty. The problem with misunderstanding emerged as the participants use the statements *take away* and *subtract from* interchangeably in their daily use of mathematics language.

The two statements like *take away* and *subtract from* though they call for the same operation, must be applied differently depending on how they appear with numbers in a word problem.

Another participant explained the word problem in the following way:

> *Any number that you take away 60 and the answer is 24. In here the order of the word problem created difficulty in understanding the word problem. The word order in the problem tells me that I must take away 60 from a number and the answer is 24*. (AF3)

This statement is similar to that of the previous participant. These two statements show that there are participants who have difficulty in understanding word problems that are written in a way that is not familiar to students. This unfamiliar arrangement provokes them to further interpret the word problem wrongly and later arrive at the wrong solution. Another participant interpreted this word problem as:

> *A number which is out from 60 and the answer is 24.This means that I have to take away that number from 60 and get 24. To get that number I take 24 from 60 and the answer was 36.* (CM3)

In his understanding he replaced the verb subtracted with the phrase out from *60*. Although there seemed to be a problem in aligning the right word in everyday English, there was a fair understanding of this word problem. One of the participants who correctly responded to this word problem rightly explained the mathematical meaning of its structure by saying:

> *This word problem is also straightforward as a number subtracted from 60 is 24 and so that means the best I have to do is to subtract 24 from 60 to get the number. Or else what I would do is to add 24 and that number to get 60 and that will confirm that my answer is correct*. (CF4)

Here, *straightforward* is used to mean that something is straight and smooth with no obstacles as there are no more complicated processes involved to get the correct solution. This participant experienced no obstacles or difficulties that might hinder his understanding of which mathematical operation to apply. The student interpreted this word problem in such a way that to obtain the solution one has to apply subtraction to the given quantities of 60 and 24 to obtain 36. This statement reveals a student that saw the arrangement of the words in this word problem as stipulating addition.

Another participant expressed a similar experience:

> *This question asked for which number is subtracted from 60 and the answer is 24. This is a subtraction question and I took 60 and subtract 24 to get the unknown number.* (CF2)

The statement shows that the participant really understands the mathematical meaning of this word problem. With that clear understanding, the participant applied the correct operation.

In this research, it is interesting to observe that almost all the participants solved this particular word problem by using the additive strategy. The participants added 24 to 36 to get 64. This was different from the mathematical intention of the word problem. The mathematical intention of the word problem was to establish an equation in which the unknown number is subtracted from 60 and the answer is 24. From the thinking of the participants they guessed and used this unknown to verify the solution. Hence, most of these participants formed the equation 60 – 24 = x. They were not using the information properly to arrive at a solution by way of establishing an appropriate equation. Although the solution was correct, yet the mathematical interpretation of this word problem indicated a difficulty in understanding the word order of this problem.

A problem commonly noted was the misunderstanding of the concept embedded in the term *uniform speed* in word problem nine (see Table 6). This was illustrated in the response of the participant who said that:

> *The term in this word problem is uniform speed. I know the word speed but when the word uniform was placed in front in front of the word speed give me more difficulty. This* is *because it is my first time to see the word uniform appearing alongside speed.* (CM1)

This statement shows a participant that has a conflicting meaning for the word *uniform*. This term is commonly attached to the dress code of certain people like school students and the participant was unfamiliar with its application in mathematics. Another difficulty was pointed out by another participant:

> *The answer is she walked 10 kilometres in one day and the difficult phrase is uniform speed and the word express*. (AF2).

This statement shows a student who has difficulty not only with the collocation of words but also with the mathematical concept expressed in this word problem. Similarly, another participant expressed difficulty in understanding the combination of these words:

> *It is these words uniform speed that created difficulty for understanding* (AF4).

Another term one participant found difficult ~~by~~ was *express*. In explaining the word the participant said:

> *Express means something you do I think [inaudible]....but I do not really understand this word express. I do not really understand the word express.* (CM2)

It is not a coincidence that this is the same participant who did not understand the mathematical operation of multiplication in word problem four (see Table 5). This statement really demonstrates students having the difficulty in using everyday words in the context of mathematics such word of which appears in this particular word problem (word problem nine).

The above statements also indicate that vocabulary does not necessarily involve lexical items. It may be the combination of items (the collocation) that caused difficulty for these participants. This particular word problem is similar to word problem five (see Table 6), which was rated by the participants as being of moderate difficulty. However, from the results it can be seen that this word problem (word problem nine) was more difficult than problem five (see Tables 6 and 7). This is because only 14 participants solved it whereas 23 participants solved word problem five. So the frequency of correct solutions for the two problems speaks about the difference in the level of difficulty. However, it is likely that the collocation of the terms *average speed* and *uniform speed* was what created the difference in the interpretation of these two problems. That is, perhaps the collocation *uniform speed* was more troublesome than the collocation *average speed*. Perhaps most participants were used to the mathematical concept of *average speed* but were confused by the use of *uniform* in problem nine (see Table 6). The use of *express* in the same problem compounded the difficulty. However, one participant demonstrated familiarity of the words' mathematical meanings:

> *When I solved that question, I used the formula to calculate speed which is distance divided by time. I frequently have seen this word speed. Most of the words and terms in the word problems I am familiar with them and just in classroom activities.* (CM4)

This response shows that frequent exposure to the term *speed* helps in creating understanding of the concept. Probably, the statement indicates that the participant could link words with mathematical meanings to the correct formula. This led the participant to establish the correct formula. Thus, it was easier as the participant applied the formula that was attached to the concept of speed. Apart from that, this statement shows a participant who is familiar with most of the words that appeared in the word problems.

However, there were participants who held misconceptions about the term *speed.* This participant claimed that although the term was understood, there was difficulty in thinking about the link between speed and its formula:

> *I understand the term uniform speed but could not correctly understand the process to find the answers.* (CM2)

This participant in fact understood the collocation *uniform speed* but failed to apply the mathematical process that lay behind this word. This shows understanding of the language of the word problem but not of the mathematical concept dealing with speed. This was different from the view of someone who could not link the vocabulary in the word problem to their mathematical meanings. This was the view revealed by the same participant when he said:

> *Yes I always saw some words and the terms in the questions but forgot to process them.* (CM2)

A similar experience was expressed by another participant.

> *I am not familiar with the words uniform speed. I do not anything about the idea surrounding speed. I do not anything and how to answer any question relating to speed if it is given by the teacher.* (AF1)

Those were further reinforced by another participant:

> *The words that I found to be difficult are uniform speed of the car and the phrase "express your answer in kilometres per hour".* (AF2)

> *In this question, words that are difficult to understand are uniform speed and express.* (AF3)

From the above statements, there were different levels of difficulties expressed by these participants. The difficulties ranged from lack of understanding of the collocation of *uniform speed* and the word *express* to misunderstanding of the concept of *speed*. Perhaps the misunderstanding of the term *speed* was because the participant had not learned this concept prior to this study. These comments show how much influence vocabulary had on these participants' understanding of the word problems that they rated difficult.

Misunderstanding of a statement with mathematical meanings was identified in some responses as the cause of difficulty. This misunderstanding caused the majority not to respond correctly to most of the word problems rated under the difficult category. One of the word problems which contained a phrase with mathematical meaning is word problem twelve (see Table 5). One of the participants explained:

> *The part of the word problem causing difficulty was "Peter took his share and divided his share into one quarter. One quarter of the remaining coconut.* (AF2)

One participant pointed out:

> *The statement that I do not know is "Peter then divided his share with his friend who got one quarter of the remaining coconut". The difficult part was caused by the one quarter of the remaining coconuts.* (AF4)

The statement shows a student that misunderstood the link between this entire word problem. This student did not understand the mathematical operations involved. Another participant responded that:

> *The statement that was difficult was "Peter then divided his share with his friend who got one quarter of the remaining coconuts".* (CM1)

Similarly another participant shared his experience as:

> *What made the question difficult is the phrase "Peter then divided his share with his friend who got one quarter of the remaining coconuts*". (AF1)

A similar experience was revealed by another participant who said:

> *The phrase that caused difficulty* was *divided his share with his friend who got one quarter of the remaining coconuts.* (AF2)

All the above statements seem to confirm that there are students who probably could not follow every part of a word problem and got lost trying to understand the problem as a whole. This was particularly the case for this word problem, which was long. There is more difficulty when there are phrases that hold mathematical meaning as in this particular word problem. The above statements show participants who are only used to word problems involving two people and with more than two operations. There was greater difficulty when the process of solving involved the concept of sharing and operations like subtraction, multiplication and division. There were similar experiences of difficulty when the participants were asked about their feelings towards word problem ten (see Table 6). The comments revealed that words with mathematical meaning had caused difficulty. This was supported by data gathered during the semi-structured recall interview.

It was interesting to observe the different types of response made to word problem eleven (See Table 6). These perhaps show the impact of syntax on the students' comprehension. Although this word problem was relatively short compared to the others yet it contained the statement *one and half times* that was a possible cause of difficulty for the participants. This word problem contained a relational statement that linked the ages of two persons together. During the interview it was recorded that some participants misunderstood the mathematical meaning of a given phrase. As a result these participants applied addition instead of multiplication. Most of these participants thought the meaning of the term *times* is addition. One of the participants had wrongly explained the entire word problem in the following way:

> *The understanding is that John one year and half older than Mary. I applied addition. This is because I understand the word times as doing addition.* (AF1)

One other participant in this research demonstrated little understanding of some elements in this word problem:

> *Mary is fourteen years old and John.... what I do not understand is John is "one and half times". So I thought that it is addition as in pidgin it is like one and half plus 14.* (AF2)

Perhaps this statement shows a participant who misunderstood the mathematical meaning behind the statement *one and half times*. Another participant had this same misunderstanding and commented:

> *The difficult phrase was one and half times older. The difficulty was in the translation of the phrase one and half times. It means just one and half years and that means he will be fifteen and half years older than Mary.* (AF3)

However, one participant understood this word problem. This participant said:

> *That is Mary is 14 years old and John is one and half times means 14 plus 7 and this is the age of John.* (CM4)

This statement shows a student who understood the relationship between the ages of Mary and John. By identifying this relationship, the student clearly explained the process involved in obtaining the solution.

It can be concluded that significant factors in the word problems that participants rated as difficult were: the unusual appearance of word order, misunderstanding of collocation and phrases that implied mathematical meanings.

4.1.4 Word problems rated as very difficult by the participants

Two of the fourteen word problems used in the study were rated as very difficult by the participants. It is interesting to observe that one of these was actually rated by me as being difficult (see Table 3, word problem fourteen). It is noteworthy too that there were far fewer correct solutions to these word problems than for the problems rated by participants as easy, moderately difficult and difficult.~~.~~ The following table contains the frequency and percentage of participants who correctly solved the word problems rated very difficult.

Table 7.
Frequency and percentage of correct solutions for word problems rated by the participants as very difficult

No.	Word problem ranked in difficulty	Frequency (%)
13	Fifty-three people got on a bus at King George and travelled to Point Cruz. Twenty-six people got off at Lawson Tama and half this amount got off at Point Cruz. How many people were left on the bus?	9 (20)
14	Tom and Paul shared a cake. Tom ate ¼ and Paul ate⅛. How much of the cake was left?	5(13)

The following participant failed to provide a mathematically correct procedure in solving the word problem:

> *If it was me, 26 minus by 53, then find the answer, how many left then take 2, this is my own idea...... and divide the amount that is 26 and find the answer and that is finding the number of people that will go down at Point Cruz.*(CM2)

This statement shows that the participant had difficulty with the English language. There is the difficulty of connecting the right operation that should be applied to the numbers 53 and 26. This shows that there is a mistake in deciding which number should come first when performing the operation. This is likely to have stemmed from not properly understanding and connecting the sentences and items in this word problem. Furthermore, there is the misunderstanding of how to divide and which numbers are to be used for division. Hence, this case clearly shows mathematical English as causing misunderstanding.

However, some participants understood part of the word problem, as was reflected by the response of another participant:

> *The part that caused difficulty to me was "Twenty-six people got off at Lawson Tama and half this amount got off at Point Cruz". I slightly understand this question but the statement that caused confusion to*

> *me is"and half this amount got off at Point Cruz". It is easy to read but there is difficulty in understanding. The difficulty lies in the mathematical English.* (CM1).

The second sentence of the word problem (word problem thirteen see Table 7) caused difficulty for this participant, who saw the difficulty as having something to do with the understanding of the mathematical English.

Another participant experienced similar difficulty regarding the same word problem. The participant pointed out that this word problem was longer than the others and contained a complex element. The comment expressed the same difficulty as the previous participant:

> *When I read this question, the first sentence was clear but the place that stated "half this amount got off at Point Cruz" seemed like the difficult part for me to understand.* (CF2)

Another participant shared a similar observation:

> *The statement that posed confusion is "half this amount got off at Point Cruz", this makes it difficult and caused confusion. I cannot connect this phrase with amount 26. Okay I took 53 and subtract 26 and the answer is 27 and divide by 2 to get 13.5 and I rounded off the 13.5 into 14.* (AF1)

This comment illustrates a student that is confused by the parts of a long word problem and cannot make connections between linguistic features and numerical values.

Although another of the participants followed the word problem there was still confusion. The participant said:

> *The question is easy but the part that makes it hard for me follow is the phrase that says, half this amount got off the bus. I do not know which amount the half is referring to. Is the question asking about half those that got off at Lawson Tama or half of the total? So I am confused of this part. Hence, it makes the question difficult to me.* (CM4)

It is interesting to note that this student clearly shows that there is higher understanding in the easy, moderately difficult and difficult word problems covered earlier. However, the experience shared here is one which reflects some difficulty in relating the different parts of this word problem. This may mean that the length of the word problem is such that it contains a lot of items that the participants might see as distracting. The above statements clearly indicate that the syntax of the word problem contributed to the difficulty experienced with it. This was also shared by one of the participants:

> *The difficulty was created by the English language used in writing the word problems. The mathematical English is not easy to understand for me. I see that the English makes it hard for me to understand the word problem that say Fifty-three people got on a bus at King George and travelled to Point Cruz. Twenty-six people got off at Lawson Tama and half this amount got off at Point Cruz. How many people were left on the bus? I do not understand this phrase half this amount got off and that created difficulty in the word problem.* (AF2).

This very detailed statement shows a student for whom mathematical English is causing great difficulty for the understanding of very long word problems. This has resulted in the misinterpretation of this very difficult word problem perhaps because of misinterpretation of the sentences in this problem. Another participant similarly focussed on the length of this word problem:

> *When word problems are long one has to read the questions properly to fully understand. They are hard to follow and can cause confusion to me.* (CM3).

These responses point to difficulties with both mathematical English and length of word problem. Perhaps when the participant referred to the length it was a reference to the longer sentences of the word problems that make up this exercise.

The study's findings for word problem fourteen (see Table 7) are very interesting. The participants rated it as very difficult (see Table 3), and only 13% (or 5 students) managed to solve it correctly. It does not contain any difficult linguistic features, and consists of one simple sentence and one interrogative sentence. However, this word problem contains fractions with different denominators. Different denominators were the feature that made this item impossible to comprehend according to several ~~of~~ participants when interviewed. Participants explained this as follows:

> *If the denominators are the same, like one eighth, tw -eighth so that we can have three eighth and then so that we can add the numerators together. However, I*

> *see that these fractions are new to me and so cannot properly answer this word problem.* (CM4)
>
> *I understand the meaning of the word problem but the difficult thing is how to add fractions with different denominators. (*CM1)

These statements show that this word problem was difficult because participants were not used to working with fractions that have different denominators. Some conceptual understanding of fractions is revealed by one of the students in that when the denominators are the same the numerators can be added. The other student (CM4) could not imagine adding fractions with different denominators. Furthermore, the word problem probably contained fractions that had never appeared in their mathematics class lesson. The appearance of the fractions with denominators of 4 and 8 prevented participants from correctly answering the problem. Even though most of the participants interviewed did not fully express their problems with this word problem, one of the participants managed to share something of it:

> *I can share a cake in halves between two people as that is what I am used to. But in a fraction like this, I cannot imagine it. I then cannot add and subtract this type of fraction.* (CF2)

This comment shows that there is some prior knowledge of the experience of dividing cakes into portions, but not in the way it appeared in this particular word problem.

Another experience was shared by the following participants:

> *I know that Tom ate one quarter of the cake and Paul ate one eighth but I do not know how much of the cake left. I do not know that it is a subtraction problem and cannot subtract three eighths from one whole.* (AF1).
>
> *There were no difficult words in this word problem but it is difficult to imagine one quarter and one eighth of a cake.* (AF4).

The above statements show that students grappled with the mathematical concept of fractions, especially when it appears in a fraction involving more steps of addition and subtraction in getting to the solution. This is perhaps because participants do not have a fully developed conceptual understanding of fractions. One of the above statements shows that students are used to fractions but not when they are applied to situations involving cake. Perhaps their understanding of a cake was ~~so~~ quite narrow and so affected how they imagine a cake when divided into eight equal pieces. Participants might not perhaps be able to bring in the idea of cake being shared in fractions other than halves.

4.2 Scores on vocabulary levels and mathematical word problem solving exercise.

In this research, a vocabulary levels test was also conducted in order to address the first research question. The scores of the vocabulary levels test and mathematical word problems were converted to percentages and presented in the form of a scatter diagram. Below is the scatter diagram showing the relationship between the scores of the vocabulary levels test and word problem solving (see Figure 1).

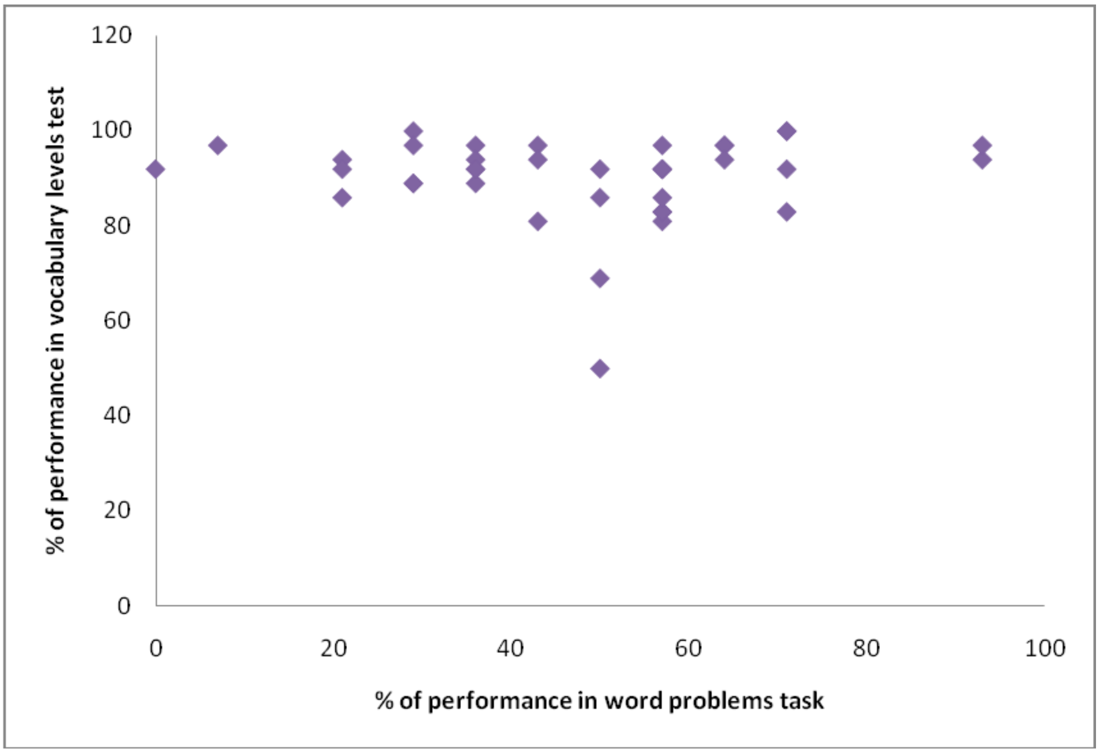

Figure 1.
Scatter diagram showing the relationship between achievements in vocabulary levels test and mathematical word problems solving exercise.

The scatter diagram represents the relationship between the participants' performance in the word problems task and in the vocabulary levels test. This is a diagram that reflects the participants' performance during the data collection period. The scattered nature of the points does not show any form of positive correlation or negative correlation between the performances in mathematical word problems and the vocabulary levels test. This unexpected situation raises more assumptions than proper explanations. The lack of correlation may be explained in a number of ways and is followed up in the discussion.

4.3 Profiles from the language and mathematical assessment portfolios.

In this research it was interesting to gather profiles of students with four different features in terms of the level of achievements in the language and mathematical assessment portfolios.

The first group involves participants that achieved high scores in the mathematical word problems, vocabulary levels test and writing task, and high achievement in the mathematical word problems. For the word problems, the interview responses of these students revealed a sound knowledge of mathematical concepts, and a deeper mathematical vocabulary knowledge which is reflected in the explanations of the mathematically important words such as *speed,* and *positive* and *negative* numbers. The writing displayed a high level of complexity. The levels of writing showed excellent use of grammar tenses and above average understanding and use of appropriate vocabulary. There were three other students out of the 45 participants with similar attributes.

The second group comprises participants who had high achievement in the mathematical word problems and low achievement in the vocabulary levels test and the writing test. In the interview, this group showed a better understanding of several of the problems. This was seen in the explanation of the mathematical words and meanings of some of the word problems rated as easy, moderate and difficult. There was a low performance in the vocabulary levels test and the level of writing was low. There were errors in grammar, tenses and sentence structure. There were five participants in this group.

The third group included participants with low achievement in the mathematical word problems and high achievement in tests of vocabulary level and writing. The word problems interview revealed that there was some degree of misunderstanding in most of the word problems rated by participants as moderate and difficult. One difficult word problem could not be answered correctly due to the lack of conceptual understanding of fractions. However, in the vocabulary and writings tests, achievement was higher. There were high scores in the vocabulary levels test. In the writing test, there were few grammatical errors and the writing was generally effective. There were three participants in this group of students.

Two of the participants composed another class of students. These are students that performed poorly overall in the entire language and mathematical assessment portfolio. In the word problems there was lack of understanding of the mathematical operation of multiplication, and of combinations of words and words with specific mathematical meanings. Writing was very poor, with grammatical errors and poor sentence construction. Above all there was no proper linking of ideas. The stories that these two participants constructed in the writing test were very hard for a reader to understand.

4.4 Summary

A number of interesting findings were made in the three schools from Solomon Islands regarding the language and mathematical assessment portfolios. The participants' ratings for the word problems were quite close to my ratings for most of the problems and significantly different for only two of them. The difference in the ratings ~~is~~ was clear in the easy and difficult word problems. There were interesting trends in the outcomes of the interviews regarding the word problems. One of it is that most participants performed well in these easy word problems as they know the basic arithmetic operations of addition and subtraction. These word problems involved the idea of change and conceptually most participants were familiar with basic addition and subtraction. In the findings the easy rated word problems showed no difficulty related to vocabulary. Despite the fact that some word problems were quite long, their simple syntax appeared to contribute to the fact that they were correctly solved.

The frequency and percentages show that more participants committed errors in word problems that were rated as moderately difficult, difficult and very difficult. The word problems rated moderately difficult contained vocabulary and collocations which were possible causes of misunderstanding to the students. It is interesting to note that the students hold different understanding to the word problems that they rated as moderately difficult. There was also lack of understanding of the required operation for one moderately difficult word problem. An interesting trend was also observed in the difficult word problems. Students said that collocations and syntactic features posed difficulties in the understanding of word problems. The unfamiliar structure of one word problem also gave trouble to most students in the problem rated difficult. In the very difficult words problems, length and syntax were troublesome.~~.~~ The length of a very difficultly rated word problem seemed to have a significant impact on the participants' comprehension. Students appeared to focus on only one part of the word problem, rather than on the entire sentence or the problem. The other very difficult word problem did not contain any difficult linguistic features but students demonstrated a lack of understanding of the concept of fractions.

In this research, however, no proper relationship was established between level of vocabulary and mathematical word problem solving ability. This is shown in the scatter diagram (see Figure 1).

Also in this, study, participants were grouped according to level of achievements. The first group included high achievers in the mathematical word problems exercise, vocabulary levels test and writing test. The second group was of those participants with high achievement in the mathematical word problems and low achievement in the vocabulary levels test and the writing test. The third group included participants with low achievement in the word problems and high achievement in tests of vocabulary level and writing. The fourth group involved participants with low achievement in the word problems exercise, vocabulary levels test and writing test.

The discussion of all these findings is presented in the next chapter.

CHAPTER FIVE: DISCUSSION OF THE FINDINGS

5.0 Introduction

The purpose of this research is to explore the role of language proficiency in the comprehending and solving of mathematical word problems for year eight students in three secondary schools in the Solomon Islands. Similar research had already been conducted in other countries including Australia, Papua New Guinea, New Zealand, Philippines and parts of Africa (Abedi & Lord, 2001; Bernardo, 2002, 2005; Clarkson, 1992, Clarkson & Dawe, 1997; Garegae, 2007; Latu, 1999, 2005; Parvanehnezhad & Clarkson, 2008). These studies like the present study were conducted with English language learners and focussed on the challenges posed by English language and mathematical learning.

The findings of this research are interesting and unexpected. Data were gathered from semi-structured recall interviews and language and mathematical assessment portfolios. The semi-structured recall interviews revealed that the students held different perceptions about the mathematical words problems of this research. These perceptions emerged from their experiences when solving the word problems. The semi-structured recall interviews revealed that students had experienced problems with mathematical vocabulary and collocation of words and syntactic features. Also it was revealed that conceptual understanding posed difficulties for the students in solving word problems. In this research, it surprising to note that familiarity of context was found to have played an important role in enhancing and facilitating the comprehension of word problems for the students. The semi-structured recall interviews also revealed that students used different strategies for solving the same word problem. An unexpected relationship was discovered between the level of vocabulary understanding and mathematical achievement in the word problems from the language and mathematical assessment portfolios. Also, from the language and mathematical assessment portfolios, it was found that there were groups of students with different levels of achievement.

These findings are so numerous, interesting and unexpected and this chapter will discuss them and relate them to the current literature. Hence, the chapter is organised as follows. It commences by discussing the students' perceptions of the word problems. Next, is a section that examines the relationship between vocabulary understanding and achievement in mathematical word problems. Following this are sections which describe the major obstacles experienced by the students in this research including vocabulary, collocation of words and syntactic features. Other areas like conceptual understanding, context and strategies which impacted on the students' comprehension are discussed as well. Finally, this chapter discusses the case of several students from this research.

5.1 Students' perceptions of the word problems

One of the findings of this research concerned the perceptions of students towards each of the word problems. Interestingly, students gave similar difficulty ratings for 12 of the 14 word problems. The students rated the word problems on a scale of easy, moderate, difficult and very after solving these word problems. It was not surprising to observe that participants expressed similar views about the word problems containing simple sentences that have mathematical meanings. It could be that they had all worked similar word problems previously. These similar experiences resulted in the similar views about the word problems used in this research. They mentioned having trouble with the vocabulary and complex sentences and other features of syntax.

However, it is surprising to note that although the participants held the same views regarding the difficulties of the word problems, a few showed different mathematical strategies for solving several of the word problems. Not only that, it is surprising to see that the participants showed different conceptual understanding in relation to the words in the word problems. The students' different ways of understanding these words influenced their perceptions of the degree of difficulty. It could be that the familiarity of the words used in these problems encouraged them to solve those word problems correctly. Conversely, the unfamiliarity of some words made the word problems more difficult for the students. This could be one of the reasons for the different frequency of correct solutions for each of the word problems in this research.

In the rating of word problems, the findings from this research revealed that the participants found two of the 14 word problems very difficult. These were problems 13 and 14 (see Table 7). Surprisingly, one of them (word problem 14) was not expected to be treated as very difficult. This is because the linguistic features in this word problem were thought to have been easily understood by year eight Solomon Islands students. Although, there was an indication of little understanding about the language of this word problem the students had trouble understanding the language in the context of mathematics. This is because the process of manipulating fractions was experienced by the students as complicated when trying to solve this particular word problem. Considered from the mathematical perspective, this word problem contained the concept of fractions with different denominators and required students to perform multiplication, addition and subtraction. Hence, it is not surprising to hear students saying that it was very difficult. Comparing word problem 14 with other difficult word problems (see Table 6) of this study, word problem 14 seemed to require a longer time in terms of applying the mathematical processes to reach the correct solution. In contrast, few participants commented about the understanding of the concept of this particular word problem (word problem 14) but could not show it in their problem solving process. The other word problem perceived as very difficult was word problem 13 (see Table 7). This was rated by the researcher as only difficult. The participants considered it very difficult as they could not understand how to relate all the sentences and numerals in the word problem in order to reach the correct solution.

5.2 Relationship between vocabulary understanding and mathematics achievement

The finding of no relationship between the level of understanding in vocabulary and achievement in the mathematical word problem solving exercise is most surprising since all the participants are English language learning students who come from a non-English speaking country. In this study, evidence showed neither a positive nor a negative correlation between vocabulary understanding and mathematical word problem understanding. This finding does not agree with those studies of Abedi and Lord (2001) and Bernardo (2002) who established a negative relationship between vocabulary understanding and word problem solving. That is, students demonstrated low ability in word problem solving because of poor vocabulary understanding. This study's findings of no correlation indicates those students' abilities in mathematics neither depends on vocabulary nor does vocabulary understanding play a role in influencing their abilities in mathematics. The findings of this research therefore do not conform to the findings of Neville-Barton & Barton (2005) who found that proficiency in language leads to better performance in mathematics. Clearly, further work needs to be done in this area to examine other factors that might be affecting the relationship established in this research.

One of the reasons for this aberrant result could be that the vocabulary test did not cover a wide enough range and was not able to discriminate sufficiently. Hence, it would be useful to see what happens if the words in the vocabulary levels test and the mathematical word problems were changed. It may be that perhaps the vocabulary test contained words that were frequently used by the students (Cuevas, 1994; Chung & Nation, 2003; Nation, 1991). A change in the content of the vocabulary levels test might produce a different finding in the relationship between the vocabulary understanding and the mathematical word problems solving abilities. It would be interesting to see if the vocabulary levels test required students to define words with mathematical meanings. A change in the content to encompass words which are used in mathematics context would test students' receptive and productive knowledge of vocabulary abilities (Nation, 1990, 2001).

5.3 Mathematical vocabulary

However, it is also surprising to observe that although there was no correlation established so far in this research between vocabulary and word problem solving, the responses from the interviews indicated that vocabulary was an obstacle for comprehension of word problems. The semi-structured recall interviews revealed that vocabulary, collocation of words, syntactic features and general understanding of word problems had created great difficulties for the students.

The word problems set for students contained technical as well as non-technical vocabulary. However, the students did not have difficulties with the vocabulary of word problems written using simple worded sentences. These simple sentences contained very high frequency and non-technical words.

Hence, from the findings of this research word problems written with non-technical words appeared to be well comprehended by students who could solve them easily. Carver (1994) and Nagy and Scott (2000), hold that students must know 90 and 95 percent of the words appearing in a word problem.

In contrast, technical mathematical vocabulary was one of the factors that caused difficulty in comprehension and solving of word problems. Although not many of the problems had difficult mathematical terms, the findings of this research can be aligned with previous studies (Cummins et al, 1988; Fasi, 1999; Garegae, 2007; Moschkovich, 1998; Padula et al, 2002; Riley & Greeno, 1988). More specifically, the students in this research are from the Pacific and that confirms the findings of Latu (2005) and Neville-Barton and Barton (2005). Nevertheless, the commonality amongst all the research was that the participants are all English language learners. Thus, this finding complemented and reinforced the studies already done in other contexts.

In this research, it is interesting to observe that students said that words such as *negative* and *positive* created difficulty to them. These two terms can be regarded as technical words obtained from ordinary English (Chapman, 1993; Garegae, 2007; Gough, 2007; Wiest, 2003) with meanings that are only specific to the context of mathematics (Latu 2005). A possible reason identified by Raiker (2002) could be that teachers might not have been able to clearly explain the technical terminology in mathematics, especially for secondary school students. Although Raiker (2002) refers to primary teachers, this explanation would hold true also for the students from the Solomon Islands. This is supported by the comment of CM1 regarding the misconception of the mathematical meaning of a negative number. Perhaps this is because positive numbers are recognised and understood before negative numbers (Lean et al, 1990).

Another possible reason for the misunderstanding of the words *positive* and *negative* was that students could not differentiate between the symbols for the operation of subtraction and the use of the minus sign to signify a negative integer. The outcome of this study showed very poor understanding of these words, suggesting that more work needs to broaden the vocabulary of these students.

It is also useful to learn from this research that some students have not seen these words used in mathematical texts. This was reflected in some participants' statements that they had not seen the words *positive* and *negative* very often. This was evident when the word problem involved the addition of these two types of integers. This finding aligns with the finding from Fischer and Rottmann (2005) that students do not easily process the meaning of a negative number. Perhaps another reason for the misunderstanding of these words was that there were no matching words for the words *positive* and *negative* in the students' vernacular (Latu, 2005). Translating these two terms to the matching words in the students' vernacular would be the convenient way to create same meanings for these mathematical English words (Taumoefolau, 2004). This would have simplified words that were causing difficulties and the students would have been able to solve the word problem containing these two terms.

I consider that the difficulty caused by mathematical vocabulary arises from what Fasi (1999) concluded as an absence of Western concepts in the society of the Solomon Islands. Although, there is a lot of considerable Western influence in some components of Solomon Islands society, such as the use of English as the medium of instruction there is little influence on mathematical learning. This might be the factor preventing students in this research from interweaving their everyday experience of the usage of certain words with their mathematical learning. On the other hand, one of the participants used the concept of number line to explain a negative number. CM4 showed that the numbers on the left of the number line are negative and the minus sign is placed in front of them. This student not only knows the meaning but has developed what Fischer and Rottman (2005) term as 'mental number line'. There is a cognitive representation of the meaning of the term negative by the student, a feature that is quite important in mathematics. The student mentally deduced the meaning of this term from the experience of a number line. The explanation of the term is an alternative meaning of the term. The other meaning of negative integer is an integer less than zero. Hence, the finding of this research concerning vocabulary suggests that meanings of mathematical terms are deduced by from students through their experience in the use of the term. CM4 used the word *normal* to differentiate a *positive* number from a *negative* number. This participant used the everyday word of *normal* to describe a positive number. Perhaps positive numbers are the numbers that students have used since learning about numbers. Hence the experience of the participant enhanced the understanding of a positive number as one that has no extraordinary sign attached to it.

At the same time, the students might have been familiar with the words that appear in the word problems of this research. This is reflected in the responses of participants like AF1, AF2 and AF4 who said that there were no technical words and the words like *tuna, noodles* and *shopping* were words that were part of their daily life. This could have contributed to their developing a better mathematical repertoire and knowledge which had enhanced their problem solving skills. Hence, they were successful in solving these word problems. Therefore, it can be suggested that a greater use of high frequency words from contexts familiar to students would also help in the understanding of word problems that do contain very technical vocabulary. All words used in this word problem are everyday words without specialised meanings. Hence, the findings of this research suggest that word problems written using the frequently used words may not affect the comprehension ability of English language learning students.

It is useful to observe from the response of AF1 that there was no understanding of the term *speed* and the ideas surrounding it. The student was therefore unable to access the relevant information to solve this particular word problem. In this case, it can be argued that the problem of understanding lies in how mathematical knowledge is conceived (Godino, 1996). In the context of this research, students should know how and where the concept of the word speed is used in order to connect it correctly with the mathematical context.

Interestingly, CM4 demonstrated the correct process for solve this word problem involving the term *speed* by connecting it with its mathematical formula. This suggests that a correct understanding of the terms in the word problem led these students to correctly apply the mathematical process needed to solve the problem. This finding suggests there has to be a link between the experiences of the students with the mathematical vocabulary encountered in order for students correctly comprehend and solve word problems. Experience contributes to background knowledge which enhances the inferring of possible meanings for the mathematical words that are used in texts (Nassaji, 2004).

The responses of the participants in this research, suggest that statements using words with mathematical meanings could contribute to incorrect solutions. Such statements were found in the word problems that participants rated as difficult and very difficult. The use of the mathematical terms with everyday language could be a contributing factor to the misunderstanding of these terms (Raiker, 2002). For example, CM2 came across the term *express* used in the mathematical context and showed through the choice of problem solving process that a misunderstanding of its meaning in the mathematical statement: *Express your answer in kilometre per hour.* Hence, as suggested by Raiker (2002) teachers should alert students when a technical vocabulary is used and teaching of that particular word should be detailed in the lesson plan. The term *express* is regarded as technical because it has the mathematical implication that the students had to mathematically manipulate the figures involving the quantities relating to *distance* travelled and *time* taken to arrive at the correct solution. CM2 knew the everyday meaning of this word *express*, yet had the trouble in explaining it when asked to do so. CM2 really misunderstood the mathematical expectation of this term. It is also fascinating that in the word problem which used the term express, there had to be a mathematical action done on the related quantities in order to get to the correct solution.

Another explanation that might hold is that the participants could not establish the relationship with *speed, distance* and *time*, let alone the mathematical formula to calculate *speed*. AF1 response presents a clear illustration of a student who could not connect concepts embedded in mathematical terms The situation observed here reinforces the explanation of Vacca and Vacca (1996) who held that some mathematical concepts have to be explained with more than a word.

It seems that in many cases there are no equivalent terms in the first language of the students. Hence there was a deficiency in the language of the students in mathematics (Fasi, 1999; Garegae, 2007; Latu (2005). This argument presented by Fasi (1990) holds for the Solomon Islands students in this research as they are learning English as well as mathematics. Hence, with mathematics being taught in English, there were probably areas that they were lacking

5.4 Collocation of words

Word collocations had been identified in previous research as creating many errors for English language learners (Leed & Nakhimovsky, 1979; Lin, 1998), and this was also frequently seen in this research. Collocation of words was noted by students in the interview as posing difficulties in solving word problems 5 and 9 (see Table 5 and Table 6). The combination of words *average* and *speed* in word problem five may have caused the difficulty in understanding the concept and calculation of *average speed*. This is parallel to Qian's (1999) view that understanding collocations of mathematical terms is more difficult than understanding a single term. This was true for ~~a~~ one participant of this research who experienced difficulty in understanding *average speed*. It could be that this student developed knowledge of the concept from prior learning experiences.

It was surprising to observe that the collocation of *uniform speed* seemed to have an impact on the understanding of students in this research. I feel that the term that created most confusion was the term *uniform*. It may be that the use of this term *uniform* acted as a modifier in this word problem (Martiniello, 2008). When the term *uniform* was used as a modifier, it distracted the students from comprehending the entire word problem. Hence a misunderstanding of this term might be the root cause of the misunderstanding and incorrect working of this word problem. The misunderstanding was observed in responses of the students, for example CM1, who said they did not understand the word *uniform* when it was placed in front of the word *speed.* Hence, the finding suggests that the obstacle ~~for~~ to understanding mathematical word problems was the multiple meanings of words ~~and~~ for students who could not decode the correct meaning in that particular mathematical word problem. Although the evidence was not compelling, there is a high chance that some collocations of words-in word problems make them difficult to comprehend and solve.

Such collocations might distract students from properly extracting the meanings of the words. For example, the inclusion of the term *uniform* distracted the students from thinking about the proper meaning of the concept of *uniform speed.* This is because the term *uniform* creates another pattern of difficulty for collocation regarding the term speed (Lin, 1998). Although there was the expectation that the key word *speed* might help them to correctly apply the mathematical formula in calculating the correct solution for this particular word problem, students still misunderstood the word problem concerning uniform speed.

Perhaps the students felt that *uniform speed* represented a totally different concept and this posed difficulty (Fasi, 1999). This concept was perhaps more difficult for the students to understand than the concept underlying the collocation *average speed.* This was indicated by a difference in the number of students who correctly solved the word problems concerning *average speed* and the word problem concerning *uniform speed*. There were more students who correctly solved the word problem containing *average speed* than those that correctly solve the word problem containing *uniform speed*. Hence, it can be suggested that different collocations posed different levels of difficulty in the word problems, even when the mathematical concepts were similar. Overall, the findings of this research propose that students need to have collocational knowledge to help them comprehend English written texts in mathematical word problems (Lin, 1998).

5.5 Syntactic features

When comparing the frequency and percentage of students with correct solutions, a higher percentage of students performed better in word problems with mathematical vocabulary than word problems containing syntactic features (see Tables 5, 6 and 7). This pattern of low performance in syntactic complex word problems tells us that syntax of word problems appeared to cause problems for students. The trend that is established in this research confirms to findings of Neville-Barton and Barton (2005) who have also done studies on non-English speaking students in various colleges in New Zealand. Coincidentally they also found that syntax similarly posed greater difficulty than vocabulary in word problems. Although, Neville-Barton and Barton's (2005) research focused on New Zealand college students, the experience of the students is similar to that of Solomon Islanders. It is interesting that although the settings and backgrounds were different yet they all experienced problems in terms of the word problems' syntax. On the other hand, the findings of this research contradict those of Ulijn and Strother (1990) who said that syntactical knowledge did not affect comprehension of word problems in technical areas. Although Ulijn and Strother (1990) referred to technical areas like computer science, mathematics is also a technical field due to the technical language used.

The studies done by Neville-Barton and Barton (2005) and Ulijn and Strother (1990) did not specifically indicate the types of syntactical features that constituted impediments for their students. In this research, however, the syntactic features that were found to be causing difficulties to the students of the Solomon Islands included the length of word problems, clauses that showed relationships and complex and unfamiliar structures. Hence the findings of this study conform to the findings of previous studies (Abedi & Lord, 2001; Larsen et al, 1978; Leach & Bowling, 2000; Martiniello, 2006; Neville-Barton & Barton, 2005; Wheeler & McNutt, 1983). Surprisingly in this research, students not only showed incorrect solutions in the word problems exercise but also complemented them with their perceptions in the semi-structured recall interviews conducted after the students did the mathematical word problems solving exercise. Below are sections discussing these features.

5.5.1 Length of word problems

It is surprising to observe from students' responses that not all of the word problems in this research had syntactic features that posed difficulties for the students and that word problems containing simple and short sentences did not pose such difficulties. This is indicated by the high frequency and percentage of correct solutions in several of the word problems of this nature (see Table 4). Hence, the findings of this research suggest that simple and short sentences in a word problem provide a base for better comprehension. These were illustrated in the responses of the students in the interview when they said that there were no difficulties surrounding comprehension of most of the words appearing in the word problems couched in short and simple sentences. Shortness of one particular word problem was viewed by the students as another factor that contributed to a better and quicker understanding and solving of that problem (see Table 4). This is even more the case when these word problems do not contain technical vocabulary and difficult syntax.

There is a trend worth noting appearing in the length of the word problems in relation to the correct solutions provided by the participants in this research. This trend is clear in word problems 1, 2 and 3 (see Table 4). The trend showed that as the length of the sentences in the word problems increased the frequency and percentage of students having correct solutions decreased (see Table 4). This requires further investigation. Perhaps more work needs to be done to verify the relationship between the length of simple sentences without syntactical complexities and the performance of students in such mathematical word problems.

In this research, some errors in the word problems may have been caused by the length of the problem. This could be the reason for low number of students finding the correct solution to word problem 13. The difficulties caused by the length of word problems in this research are paralleled in the findings of Martiniello (2006, 2008) who also recorded that length was a main feature causing difficulty for comprehension and solving of word problems. It is interesting that a word problem that is relatively longer than any other problem is word problem 12 (see Table 6). The length was seen as a distracter and caused confusion to participants. This feature was also evident in the response of CM1 to this problem. Similar evidence was identified in the very difficult word problem 13 (see Table 7). This problem is long and also contained items that distracted the thinking of the problem solvers. The students pointed out that the items *half the amount* had been a major cause to understanding this problem. Participants CM1, CM4, AF1 and AF2 all blamed the items of the word problem as causing distraction in their problem-solving strategy. Perhaps the reason could be their inexperience in solving lengthy word problems, so that inability to concentrate fully prevented them from connecting the important features of the word problems 12 and 13.

5.5.2 Mathematical clauses that showed relationship

One impact of syntactical difficulty is the difficulty of representing the relationship between the variables (Mayer, 1982). This was reflected in the response of CM4 who did not know how to relate the variable *half this amount* which appeared to be an important linguistic feature of word problem 13 (see Table 7). Perhaps the participants had difficulty in connecting the variables and numerals in this particular word problem. Interestingly, students also were caught in choosing the wrong mathematical operation because of the difficulty in connecting this feature with the appropriate quantity in the word problem. This was perhaps due to inability to understand the linguistic variables and fitting them with the appropriate operation because students were misled by the distracters or irrelevant information in the word problems (Mayer, 1982). This suggests that a wrong response could be due to wrong assignment of the numeral to the variable in the word problem or to confusion over which variables to assign the quantity to. The wrong assignment of numerals to variables resulted in the poor performance of the word problem 13 (see Table 7). It could be that because in this particular word problem there were more than two quantities given participants found it difficult to relate the quantities to the variables. Participants had difficulty with the word problem containing the words *half this amount.* They reported that they could not relate *half this amount* to the other quantities in the problem. The students not only failed to solve this word problem, they also classified it as one of the very difficult word problems in the entire set. This perception was complemented by their low performance on this word problem.

Another mathematical clause that caused difficulty for students is in word problem 12 (see Table 6). In the interview AF2 and AF4 noted that they had been distracted by the part of the word problem *one quarter of the remaining coconuts*. It is interesting that this finding is similar to that of Martiniello (2006), who found that longer noun phrases caused problems. In this research, the object in the word problem is thought to be familiar. Hence the difficulty lies in the difficulty posed by the length of the clause. Perhaps another reason for the incorrect solving of word problems was difficulty in understanding relation propositions (Xin, 2008).

Another reason for difficulty in solving word problem 11(see Table 6) was the misunderstanding of the relationship between the given variables and quantities. The variable of this word problem *one and a half times* is a linguistic variable (Lepik, 1990) and participants had difficulty in relating it to the quantity that denotes the age, which is *14 years old*. This particular word problem involves comparison and was difficult. The response indicated that students saw it as a language problem. This was perhaps due to failure to understand the mathematical implication of the phrase *one and half times*. This confirms to the findings of Latu (2005) and Shaftel et al (2006) who found that mathematical phrases had hindered students' understanding and solving word problems.

The concept used in word problem 11 in this research is termed ~~as~~ multiplicative comparison (Jitendra et al, 2001). In this research, only 12 of the 45 participants correctly solved this word problem. The low rate of correct solution seems to agree with claims by Riley et al (1983) and Mwangi and Sweller (1998), who assert that comparison word problems are more difficult than combine and change word problems. Perhaps a reason for the low yield was the difficulty in linking the operation of multiplication to the quantities given in this word problem. The general response was that the participants felt that the terms in this word problem called for addition. For example, AF1 said that addition was the operation required between *one and half* and *fourteen* to get John's age. This perhaps was due to the experience that the students have in relation to the use of the term *times* in their daily conversations.

Shaftel et al (2006) argued that the comparatives appearing in word problems are language features that overlap with the content knowledge and thus complicate the word problem. This is probably one of the factors causing difficulties for the participants in this research. Perhaps when participants saw the words *one and a half times*, they did not fully understand the concept and substituted it with words that they thought had similar mathematical operations (Lean, Clements & Del Campo, 1990). A point to note here is that the clause *one and a half times* was wrongly connected with the mathematical operation of addition. From that, most of the students used additive strategy for solving that particular word problem. Perhaps the operative pattern identified from this word problem was inconsistent with the required arithmetical operation. This was reflected in the interview with CM4 who replaced the word *times* with addition instead of multiplication. Hence, it is argued that to understand a word problem, students also need to use relational thinking about the word problem (Koehler, 2004). Koehler (2004) explains relational thinking as the different relationship students recognise and create between quantities, operations and expressions. I consider that relational thinking is strongly related to how well a student understands the relationships of different quantities in a word problem.

5.5.3 Complex sentences in word problems

In this research, students were not able to link the information in the word problems that contained complex sentences. Several of the word problems in this research contained complex statements that students could not really understand. This finding is in line with previous studies by Latu (2005), Shaftel et al, (2006), Larsen et al (1978) and Leach and Bowling (2000), all of whom found that complex sentences were difficult for students to comprehend. In this research, students identified the complex sentence in word problem 13 (see Table 7). The word problem is:

> Fifty three people got on a bus at King George and travelled to Point Cruz. Twenty-six people got off at Lawson Tama and half this amount got off at Point Cruz. How many people were left on the bus?

The first part of the problem that stated; *Fifty three people got on a bus at King George and travelled to Point Cruz*, was easy to understand by most of the students as it was as a simple sentence. However, the second sentence of the word problem was a complex sentence and created much difficulty. This was one of the very difficult word problems encountered by the participants. Most students did not understand which number the statement *half this amount* was referring to. This statement distracted students trying to create a relationship between the pieces of information presented in this word problem. This difficulty was identified when the whole of the word problem was broken down into separate parts. Hence, this research has reiterated that complex sentences pose difficulties to students because they contain statements that students have trouble relating to other parts of the whole structure of the word problems. An interesting point to note is that in Larsen's (1978) study, syntactical complexity impacted on arithmetic performance for students with learning disabilities although in this research the students did not show any learning disabilities.

5.5.4 Unfamiliar sentence structure in word problems

Participants in this research also said they had trouble when the word problems contained an unfamiliar sentence structure (Leach & Bowling, 2000). An example was word problem 8:

> A number is subtracted from 60 and the answer is 24. What is the number?

Perhaps this unfamiliar sentence structure was interpreted as inconsistent language by the students as it was not consistent with the way word problems were typically written. This inconsistent language hindered understanding of the word problem, as reflected in the response of CM3 who had to take away 24 from 60 in order to get the solution. Although this word problem requires the arithmetic skill of subtraction, an algebraic equation needs to be established before solving this word problem. This slightly different strategy was problematic because of the problem solvers' cognitive preference for a particular order (Lewis & Mayer, 1987). This preferred order had perhaps developed from their previous experience with similar word problems. Hence, most of the students applied their preferred order of arranging the equation to solve this particular word problem. It is also surprising that the 31 students who had correctly solved this word problem held their own preferences in terms of the structure of the mathematical equation. Their preference did not follow the expected mathematical way of answering such word problem.

5.6 Conceptual understanding and comprehension in mathematical word problems

A surprising finding was that although students comprehended the overall meanings of most the word problems in this research, the majority demonstrated poor conceptual understanding of a few of them. Poor conceptual understanding was evident in a problem involving fractions, multiplication and subtraction. This section attempts to account for these misunderstandings. This section also discusses some of the different strategies that students applied to solve the same word problems.

5.6.1 Misunderstanding of word problems with fractions with different denominators

An unexpected finding was that participants gave a somewhat inaccurate explanation of the process they had applied in solving word problems involving the concept of fractions (see Table 7). It is interesting to observe that 40 out of the total number of participants did not manipulate fractions properly. It is also surprising that this word problem did not contain any linguistically difficult features. This was stated by CM3 and BM1 when they said that there was nothing difficult about the language used but there was a problem ~~of~~ with imagining *one eighth* and *one quarter* of a cake. In this research students expressed difficulty in their conceptual understanding of fractions.

This was even more the case when the fractions were of different denominators. The participants perhaps had not developed a schema regarding the addition of fractions with different denominators (Chinnapan, 2003). When there is a fully developed schema, students can visualise the types of fractions involved in the word problems. In order to develop the schema, teachers need to teach for the understanding of fractions. Developing a schema regarding fractions students will be able to recognise the relationships in word problems containing fractions (Morales, Shute & Pellegrino, 1985). This should help students to understand the problem and apply the appropriate procedural knowledge to correctly solve a word problem involving fractions.

5.6.2 Misunderstanding of multiplication

Surprisingly one of the word problems contained simple sentences yet the findings show poor understanding of the concept embedded in it. The word problem with the simple sentence is as follows:

> A number is multiplied by six and the answer is 36. What is that number?

Lack of understanding was reflected in the response of CM2, who chose the wrong operation addition, instead of multiplication. This was an unexpected finding because familiarity with multiplication should be part of students' learning by year eight as multiplication is a common operation in mathematics classrooms, according to the Solomon Islands curriculum (Ministry of Education, 1997). Nonetheless, this participant's mistaken choice of operation could perhaps be traced to lack of experience in the early grades.

Possibly, however, the student CM2 simply failed to select the correct operation of multiplication despite having a familiarity with the symbol of multiplication (x) even when it appeared in a word form. It could be that this student was looking quickly for the specific situation or information and could not envision the mathematical model of the operation (Nickerson, 1985). As a result, this particular student was unable to identify the mathematical relationship between the items in the word problem.

5.6.3 Incorrect interpretation of word problems involving subtraction

A conceptual misunderstanding might arise from misinterpretation of a word problem (Cummins Kintsch, Reusser & Weimer, 1988).This hypothesis can be related to the students' solutions of word problem 8 (see Table 6). This word problem involved subtraction and establishing an algebraic equation. However, in this research, it was surprising to find that participants said that they had used a different strategy without expecting to arrive at the correct solution for this word problem. Linguistically it was expected that students would establish equation 60-x=24. Surprisingly most students formed the equation 60-24=x. Mathematically, this equation is correct, yet its choice indicates that students did not understand the linguistic nature of this particular word problem. Perhaps this was because of the way they had been taught to interpret such word problems. There is also a possibility that students resort to this problem solving strategy because it is the one preferred by their teachers (Leikin, 2003).

Another possible reason was the ineffective use of key words (Jitendra et al, 2001). In this research, the participants saw the term *subtracted* and resorted to creating the mathematical procedure of subtracting 24 from 60. Although, these participants obtained the correct solution, the use of key words is seen here to be ineffective (Jitendra et al, 2001; Kelly & Carnine 1996). This approach would definitely have affected their mathematics comprehension.

5.7 Different strategies for solving the same word problem

It is surprising to observe that the participants applied different strategies yet arrived at the same solution. These strategies were perhaps developed by the participants in their previous schools or taught by their teachers (Adams 2003).

For example, when asked about her understanding of the word problem, *A number is multiplied by six and the answer is 36. What is that number?* CF2 used the concept of square and square root. Perhaps this was because there was recognition of the basic fact that 36 is a perfect square and its square root is 6. Additionally, CM3 resorted to applying the basic facts of multiples of 6. This suggests that students used the strategies for word problem solving that they were comfortable with to interpret the concepts behind them. The different strategies employed by the students suggest that in some word problems linguistic features are independent of mathematical understanding. Perhaps these different strategies emerged from individual students' different levels of reasoning.

5.8 Importance of context in word problems

Problems do not appear in isolation (Godino, 1996). The participants' responses to the word problems were influenced by the written materials and more importantly by the context (Galda, 1990). Although it was not the intention of this research, it is surprising to observe that students regarded the context as another factor that impacted on their comprehension of the word problems. It may be because the word problems were designed to present a context that was familiar and friendly for the students. Hence, the vocabulary and social references used in the word problems enabled the students see a relationship between the mathematical quantities and their real world knowledge (Olkun & Toluk, 2002). This is made obvious in the responses of students about familiar objects like *tuna, noodles* and *shopping.*

In the findings, it was revealed even when word problems were lengthy, students could still understood them because of the familiarity of the context. Thus, the findings of this research concerning context agrees with those of Stern and Lehrndorfer (1992) and Stetic (1999), who also found that familiarity of context influenced comprehension of the text. Researchers like Stern and Lerhndorfer (1992) found that word problems with neutral situations were more difficult for students to work with than word problems with familiar situations, especially in comparison word problems. However, their study was done with first graders. In this research, situations and contexts that enhanced understanding were seen in the word problem involving money, shopping, grocery and the mathematical operations of addition, subtraction and multiplication. As the elements of contextual objects in the word problems of this research were a major part of the students' lives, they could easily understand the intention of the word problem.

This research suggests that context is an additional knowledge that is needed to understand mathematical word problems (Roth, 1996). The contexts referred to in the word problems included settings and situations that were familiar to the students. These settings and situations allowed the students to activate their contextual schemas to create a better understanding of the word problems (Zambo & Zambo, 2004). The findings of this research agrees with the sentiment shared by Bilsky et al (1986) who argued that context had a positive effect on the comprehension abilities of students required to solve word problems.

5.9 Different groups of students from the language and mathematical assessment portfolios

On the basis of the language and mathematical assessment portfolios, students were able to be classified under four achievement categories. This was surprising, as prior to conducting this research my perception was that students would only fall into categories that were in accordance with the semester assessment of their teachers in English and mathematics.

Only three students showed high achievement in the language and mathematics assessment portfolios. This did not necessarily agree with their semester assessments made before they were selected for this research. Although three individuals constitutes a very small portion of the total of 45 participants, it is a significant finding given that these are all English language learning students who predominantly speak the local vernacular. This finding was different from Bernardo’s (2005) who saw that first speakers of English performed more strongly in mathematics than those that were English language learners. Perhaps this finding related to general intelligence (Aiken, 1972; Clarkson & Galbraith, 1992). The general intelligence of these three might be linked to their cognitive abilities in these two subjects (Colom, Espinosa, Abad & Garcia, 2000). These students perhaps have stronger cognitive abilities than the others in this research. Although this study did not measure their intelligence, it did accumulate evidence that these participants were able to analyse and correctly solve word problems. Clarkson and Galbraith (1992) argued that higher competence in language and high scores in mathematics are features of general intelligence. Additionally, the general intelligence of these three participants put them in a better position to express themselves in a more meaningful way in the writing task concerning the advantages and disadvantages of wantok system in the Solomon Islands. Their higher level of intelligence helped them to easily understand the tasks and respond to them with relative ease. However, further research would be needed to measure the intelligence of these participants as there are many factors to be considered.

It is also interesting to see another group of students who had high achievement in the mathematical word problems accompanied by low achievement in the vocabulary levels test and the writing test. This group of students is interesting as their achievements disagree with other findings regarding the relationship between high language proficiency and mathematical achievements (Cocking & Mestre, 1988; Garegae, 2007; Macgregor & Price, 1999). Perhaps, their high achievement in the mathematical word problem exercise of this research was due to strong cognitive mathematical abilities and their low performance in the English language tasks ~~a~~ low competence in English language.

Perhaps more surprisingly, the study also identified a group of students with low achievement in the mathematical word problems and high achievement in tests of vocabulary level and writing. This finding disagrees with that of Bernardo (2005) who found that there was a link between English language proficiency and mathematical abilities. A point to note is that the students in this current research could have the same level of English background as in Bernardo's (2005) study. Perhaps these students show high competence in language but could not apply their language skills to translate the word problems. Perhaps they had developed a better background in language prior to participating in this research. Hence, they had developed strength in English language rather than mathematics. Perhaps these students are more interested in the subject of English than mathematics. However, there needs to be further research about favourite subjects and whether these are related to high achievement.

In addition there was the group of students who performed poorly in the entire language and mathematical assessment portfolios. These cases of general poor performance can be used to further verify the current trend in language proficiency and mathematical achievement that have been established by previous researchers (Cocking & Mestre, 1988; Macgregor & Price, 1999). Poor overall performance is not surprising as these students are English language learners living in a place where English language is not often spoken. Thus, this means that their low ability in the English language might have impacted on their mathematical understanding. The low achievement can be linked to important factors. Some factors that are stated by Elley and Mangubai (1983) which might explain this low performance include low motivation, minimum exposure to English and poor quality of English language teaching. Their study was done in a South Pacific country in which language is the second language. It could be that the explanation of Clarkson and Dawe (1994) also holds for the group of students in this present research who were likely to be cognitively disadvantaged and perhaps had trouble understanding the tasks stipulated in the language and mathematical assessment portfolios. An important contributing factor is that English language is only taught by other non-native speakers, which allows for faults to occur (Elley & Mangubai, 1983). This faultiness in English is clearly an obstacle to learning and understanding of mathematical word problems. However, more studies need to be conducted in this area to verify or discount the findings of this research.

5.10 Summary

The above discussion has reaffirmed the discourses concerning the role of language proficiency in the comprehension and solving of mathematical word problem solving. In the context of the Solomon Islands, there is evidence from this research that language proficiency has a significant impact on the way in which students comprehend and solve word problems. The research has established that there are difficulties in vocabulary, collocation of words and syntactical features of mathematical word problems. This was demonstrated by the language and mathematical assessment portfolios and complemented by the students in the semi-structured recall interviews. In spite of this, this research established no significant correlation between mathematical word problem solving and vocabulary understanding. This is quite surprising, as these students are all English language learners and the expectation was different from the findings. This chapter has also looked at reasons to explain the levels of achievement found by the research in the language and mathematical assessment portfolios. In the next chapter, I will discuss the implications, limitations and conclusions of this research.

CHAPTER SIX: CONCLUSION

6.0 Introduction

This study set out to explore the role of English language proficiency in students' comprehension and solving of mathematical word problems. This chapter provides a summary of the major findings and also discusses the study's limitations and implications for further research. Several interesting findings were established in this research. The data were obtained from the language and mathematical assessment portfolios and the semi-structured recall interviews. The findings of this study strongly indicate that language proficiency has a role to play in influencing Solomon Islands students' comprehension in the solving of mathematical word problems.

Briefly the key findings of this research are as follows:

- There was no significant correlation between students' vocabulary understanding and their comprehension of mathematical word problems as demonstrated by a scatter diagram (see Figure 1).
- There were difficulties associated with the vocabulary and syntactical features used in the word problems. The students had trouble with vocabulary that was part of ordinary English but which also had specialised mathematical meanings. Syntactic features like length of problems, complex sentences, unfamiliar sentence structures and collocation of words are deemed to cause major difficulties to students' comprehension of mathematical word problems.
- Word problems involving fractions with different denominators did not pose any linguistic difficulties; however, there was a strong indication of conceptual misunderstanding by students in the area of fractions.
- Familiar contextual factors play an important role in facilitating comprehension of mathematical word problems.
- The participants in the study fell into four different groups. These groups comprised i) students with high ability in mathematics, and superior vocabulary knowledge and writing skill; ii) students who had high achievement in the mathematical word problems and low

achievement in the vocabulary levels test and the writing test; iii) students with low achievement in the mathematical word problems and high achievements in tests of vocabulary level and writing; and iv) students with low achievement in mathematical word problems, vocabulary levels test and writing.

The findings of this study should add to the growing body of knowledge regarding students' mathematical understanding and language difficulties, especially in the Pacific islands context. An interesting feature of the participants of this research is that they spoke more than two languages. Nevertheless, the findings of this research conform to other research that had already been conducted on students who spoke only two languages and whose second language was English. This study sets the basis for future related studies in the area of mathematics in the Solomon Islands. These could be extended to cover other Pacific countries.

6.1 Limitations of the current study

In the process of data collection, I experienced difficulties posed by a number of factors, including time, the closed systems of the participating schools, the relationship between researcher and students, and sample size. Below are sections explaining these limitations.

6.1.1 The time factor

The first limitation is concerned with the amount of time allocated to do my field work and the availability of students on those days that I had made an appointment to conduct the semi-structured recall interview. My research trip was made at a time when the schools were moving towards the end of the semester. One of the schools (school B) had organized outdoor activities that prevented me from implementing the semi-structured recall interview with the students. As result I have not interviewed participants from this school. This limitation could be addressed by way of careful planning and pre-arrangements undertaken prior to making a research trip to the Solomon Islands so that the timing of a research program fits in well with the schools' programs. This would mean that a researcher would not disrupt the school's programs and that teachers could allocate time for a researcher to implement data collection.

Some degree of procrastination prevailed amongst the teachers and ~~so~~ there was frequent postponement of the days f~~or~~ assigned for implementing the language and mathematical assessment portfolios. The common reason given was the absence of the relevant teachers and principals. Slowness in getting formal consent from the participants' parents was another factor which affected the whole process of data collection and the research outcome.

I think the time lapse between the language and mathematical assessment portfolios and the semi-structured recall interview was also long. Maybe it would have been better if the students were allowed to work on the word problem during the interview. That might have given me richer data. The break caused participants to forget what had been done during the word problem solving exercise.

6.1.2 The schools' closed systems

The schools have a closed system that cannot be easily accessed by an outsider. Thus, it was quite difficult for me as researcher to interrupt lessons and students' time for the English and mathematical word problems solving exercise. Teachers had their lessons well planned for their periods and less priority was given to the research tasks. As a result, I had to wait for periods when teachers had not planned tasks for their students, and these were towards the end of the week. This also affected the inputs of the students to the research tasks.

6.1.3 Relationship between the researcher and the students' culture

In this research, although I am from the same country as the students, I felt the relationship between me and the students was another limitation to collecting more data. The students and the schools considered me an outsider, which made it very difficult to have conversations. A major barrier existed between me as the researcher and the participants who were students. This was even more significant when I was interviewing female students. Cultural reticence prevented the participants from really expressing themselves about their experiences in solving word problems. The interview did not really extract much from the students perhaps because of this relationship that seemed forced and artificial. This was also reflected in some responses involving only one word or short remarks, as seen in the results. However, there were students who expressed themselves fully during the interview.

6.1.4 Limitations due to sample size

The sample size for the language and mathematical assessment portfolios was relatively small. This may have contributed to the non-significant correlation between vocabulary and mathematical understanding. Hence, it may be suggested that the sample size be increased in order to cover students with a wide range of abilities in mathematics and English language. It is recommended that the study be extended to cover schools in the rural areas and other islands of the Solomon Islands. A larger sample size might enrich the data. This might also help provide a different type of correlation between mathematical understanding and vocabulary understanding. An increase of the sample size might allow those with wrong solutions to come forward and share their perceptions as well. Hence, there would be data describing incorrect approaches to the word problems as well as the correct approaches that were described in this study.

6.2 Implications

The findings of this research need to be acknowledged not only by teachers but also by scholars who are interested in future research in the area of language and mathematics. Hence, the implications of this study are divided here into implications for pedagogy and research.

6.2.1 Pedagogical implications

The findings of this research have important implications for teachers and the stakeholders of education.

1. Teachers should notify the students that mathematical language has its own register and that some everyday words used in this register have specific meanings in mathematics. In this way teachers could encourage students to start recognising words that are important in mathematical register.

2. The findings reveal that context plays a major role in the understanding of mathematical word problems. Teachers could introduce contextual

word problems in their lessons. This might encourage students to think and apply mathematical knowledge to situations that are familiar. It would enable them to develop an understanding of both the fundamental mathematical ideas they have learnt and the application of basic mathematical concepts in realistic situations within the Solomon Islands. The use of contextualised word problems should help students to realise the importance of mathematics in daily living.

3. Teachers could also encourage students to write journals in English about the knowledge learnt in mathematical lessons. Such a practice should develop students' reflective skills as well as enhance and improve their language proficiency. It would enable students to explain mathematical knowledge and procedures for solving word problems in a way that is more meaningful to them. It should also help improve students' mathematical thinking and writing skills. Mathematics and English teacher should work together to expose students to good writing skills by taking a lead in providing samples of journals that they have produced.

4. Curriculum designers should establish a framework which encourages teachers to introduce mathematical word problems at the primary level. This could be achieved through designing simple word problems where children can have hands-on experiences like buying and selling, and comparing sizes of different objects. Links could be created with materials that the students have access to in their daily living. Introducing word problems at an early age might help students to realize and appreciate that mathematics is used in everyday situations.

5. Teachers can properly refine their lesson planning and execution to encourage the correct meaning and use of mathematical terminologies. They could require students to write out the meanings of the mathematical words from their own understanding. These definitions could be refined later as the students' progress in their learning.

6. The practice of code switching for the purpose of explaining words with mathematical meaning needs to be encouraged. Code switching is one

of the resources available to bilingual speakers. It is a strategy in it own right that is relevant to mathematics learning. The question is which language should the teacher use for this purpose in the Solomon Islands and whether it will be effective in the Solomon Islands This practice would be effective only if the mathematics teacher is well versed in the common vernacular to choose the right synonym that matches the mathematical vocabulary used to explain the concept. From this, there is assurance that correct links will be created between the translations of the terminology from English language to pidgin.

7. There might be collaboration between mathematics and English teachers in the same level. The English teachers could help in explaining the features of mathematical word problems such as mathematical terms, phrases and vocabulary that are seen to be hindering the mathematical understanding of students. Additionally, English teachers should include the mathematical vocabulary as part of exercises given to their students to learn. Students could be encouraged to use this vocabulary to write simple sentences that carry mathematical meanings. This should enhance and improve their sentence construction skill as well as reinforce their knowledge of mathematical English.

6.2.2 Research implications

This study can be treated as the platform for other related studies. An important area that needs further investigation is the effectiveness of code switching. Mathematical tests could be designed in pidgin and English to assess the students' level of understanding of mathematics in both these languages. Observations could also be done on teachers who teach and switch codes between pidgin and English. This could be followed up by interviews to assess the students' understanding of the explanations done through the process of code switching in class. It would also be interesting to see which of the concepts in mathematics could make use of the practice of code switching for explanation. This is because some concepts cannot be explained in pidgin as there are no matching words for those concepts in pidgin. Such studies could also help determine at which level code switching should most usefully be introduced by teachers.

1. It would be interesting to increase the numbers of word problems and to design all word problems with the same number of items. This would allow researchers to concentrate on variables like vocabulary and mathematical statements. Such a study could focus on mathematical vocabulary and word problems. Increasing the number of word problems would provide more data and thus allow more detailed analysis.

2. A study could be designed that would gather teachers' perceptions of the difficulties that they encountered in teaching mathematical word problem solving. This study would include their strategies of teaching word problems in the context of the Solomon Islands. It would be interesting to gather teachers' perception on the use of socially and culturally familiar items and events in mathematical word problems.

3. Given the method used to interview students, a different approach of collecting data from students in the Solomon Islands needs to be considered. From the experience of this research, rich data were not collected from students by the use of the semi-structured recall interviews. Hence, any researcher who wishes to work with students in the Solomon Islands might want to consider other methods besides interviews.

4. It would be interesting to do further studies on how to investigate the use of word problems contextualised for Solomon Islanders. In that study, contexts could be neutral or familiar and word problems should depict such situations.

6.3 Concluding thoughts

The curriculum development department within the Ministry of Education and Human Resources Development of the Solomon Islands encourages teachers to raise students' mathematics competence. It is hoped that the findings of this research might help the Ministry to make policy decisions that will address issues of mathematics learning in the areas of word problem solving and the language used to teach mathematics by incorporating the findings of this study in any future curriculum review.

It is also hoped that the findings of this research might help inform teacher education practices in the Solomon Islands, especially in the School of Education at the Solomon Islands College of Higher Education, which is responsible for educating future mathematics teachers. Future mathematics and English teachers need to be made aware of the ongoing and associated problems of language and mathematics and should be equipped with strategies to help alleviate them.

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APPENDICES

Appendix 1. Information letter to the Permanent Secretary of Ministry of Education

From: Ambrose Malefoasi
7A Yorkshire Street
Silverdale
Hamilton 3216
New Zealand
Date:
To: Permanent Secretary – Mrs. Mylyn Kuve
Ministry of Education Human Resources and Development
P. O. Box G28
Honiara
Solomon Islands

Dear Mrs Kuve,

<u>Subject: Notification of research</u>

I am Ambrose Malefoasi from Malaita province. I am currently a Master of Education (Mathematics) student in the University of Waikato. Prior to undertaking further studies, I have been a teacher of mathematics for the past six years both in secondary school and the Solomon Islands College of Higher Education and University of South Pacific, Solomon Islands centre.

I hereby officially submit this letter as a notification in regards to a research that will be conducted in Honiara towards a Master of Education (Mathematics). This research will be implemented as of the beginning of September. For this research three schools under the Education Authorities of Honiara City Council and Church of Melanesia will be engaged. These schools are Mbua Valley Community High School, Koloale Community High School and Saint Nicholas High School.

The research will be implemented on 45 year eight students (form 2) from the selected schools under the said education authorities. That is around 15 students per school. These students will be treated to surveys and individual interviews. Surveys will be conducted on English proficiency, vocabulary levels and mathematical word problems. The survey will be conducted during the students' normal class lesson times. The purpose of these three surveys is primarily to elicit information about their level of English and their understanding in mathematical word problem solving.

After this, five students selected from this cohort will be required to participate in an interview. The interviews will be on the sources of difficulties experienced by the students whilst performing the word problem solving task. Here, I wish to explore the role of language proficiency in students in mathematical understanding and word problems solving. Hence, I wish to gather information regarding their level of English proficiency and how it impacts their mathematical understanding of word problems. The interview time will be conducted during a time convenient to the participant's within school official hours. I will be prudent, not to interfere or disrupt in any way the school's official time table. Each interview should not exceed 30 minutes. Each interview will be audio recorded and be later used for analysis.

The research will strictly adhere to the University of Waikato Human Research Ethics Regulation (2008) and the Research Act of Solomon Islands (Solomon Islands Research Act, 1982). In this research, the participants' inputs will be respected and termed as very confidential. They will be informed on the outset about the ethical issues surrounding research and their personal well being. Such ethical issues include their right to decline and withdraw from participating or if they did not wish to continue any further in the process. Pseudonyms will be used instead both for the names of the schools and the participants. Informed consent will be sought from the schools and the potential participants.

Thank you so much for acknowledging this notification.

Yours sincerely,

Ambrose Malefoasi

Cc: Education Secretary-Church of Melanesia.
Cc: Education Secretary-Honiara City Council.

Appendix 2. Letter to principals and consent form

28th August 2009

Dear: ___________________

<u>Subject: Seeking Approval for research in Kolale Community High School</u>

I am Ambrose Malefoasi from Malaita province. I am currently a Master of Education (Mathematics) student in the University of Waikato. Prior to undertaking further studies, I have been a teacher of mathematics for the past six years both in secondary school and the Solomon Islands College of Higher Education and University of South Pacific, Solomon Islands centre. Currently, I am processing matters related to my research which I intend to implement sometimes in September. My research will focus on the relationship between English proficiency and mathematical word problems solving. I wish to explore the challenges that our students are faced with when doing exercises specifically in word problem solving. I wish to gather information regarding their level of English grammar and vocabulary knowledge and how these impact their mathematical understanding and performance in word problem solving.

I have selected your school with two other schools in Honiara for this study. The focus is on year eight students (Form 2). This study will be conducted on 15 students which should include both males and females. These students will be involved in three surveys on English proficiency, a writing task, vocabulary levels test and a mathematical word problems exercise. I would like to interview five students from the same group. These students will be selected to represent a spread of proficiency.

Briefly, the data collection methods will include a survey and individual interview. The survey will be conducted at a time that is considered and agreed upon by the teachers responsible for the subjects and me. The purpose of these three surveys is primarily to elicit information about students' level of English and their understanding and solving of mathematical word problems. The interview will be conducted during a time convenient to the participants and will be negotiated with the teacher if this is in the school time. Each interview should not exceed 30 minutes. Each interview will be audio recorded and be later used for analysis.

I wish to assure you that the research will strictly adhere to two important regulations. One of which is the University Of Waikato's Ethical Conduct in Human Research and Related Activities Regulations (2008). Another important regulation is the Research Act of Solomon Islands (Solomon Islands Research Act, 1982).

Participants' input into the research will be confidential. Both the participants' and school's identity will be kept anonymous. Pseudonyms will be used instead of the names of the schools and the participants. They will be informed on the outset about the ethical issues surrounding research in relation to their personal well being. The ethical issues include their right to decline and withdraw from participating if they did not wish to continue further in the research process. An informed consent form seeking their approval will be signed prior to engaging them in these tasks.

Therefore, prior to undertaking this project I wish to seek an official approval from you as the principal of this particular school. It is very much appreciated if a copy of this correspondence is given to the teachers responsible for teaching mathematics and English in form 2. This is so that times can be arranged for the actual implementation of the surveys and interviews.

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

I await your response. If you require further information I can be contacted through email am149@students.waikato.ac.nz or malefoasi@hotmail.com or you can email my supervisor Dr Margaret Franken on franken@waikato.ac.nz

Thank you for your consideration.

Ambrose Malefoasi

Cc: Form 2 English teachers
Cc: Form 2 Mathematics teacher

Principals' consent form

I____, Principal of______________________________ School gives consent for Ambrose Malefoasi to work with fifteen students in form 2. This will be in tasks concerning his research in English proficiency, vocabulary levels tests and word problem solving. I understand five of these students will also be interviewed and audio recorded for later analysis. I understand that all information including my name, the students' name and the name of the school will be kept confidential. I understand that these activities will not disrupt the school program and will be done in a classroom and at a quiet place with the other teacher present.

Signed: ______________________________

Date: _____________________________

Appendix 3. Consent letter to parents/guardians and consent form

To the parent(s)/guardians of ________________________

I am Ambrose Malefoasi, I come from Malaita province and had been a teacher of Mathematics for the past six years. At the moment, I am doing a Master of Education (Mathematics) at the University of Waikato, in New Zealand.

As part of my studies, I am doing a study about students in Mathematics in the Solomon Islands. The research that I am going to do is on the English grammar and vocabulary and how that influence mathematical word problems solving.

So we will be doing tasks that in vocabulary level, writing and solving of word problems. Each of these tasks will take approximately 30 minutes. After these tasks few of you will be chosen for an interview. I will pick students for interview because they have different scores in the tasks. The interview will take no longer than 30 minutes and another teacher will be present. The interview will be taped so that I can listen to their answers. The tapes will be destroyed after the research is finished.

The students' scores and interview answers will be kept confidential-they will not be shared with anyone. The students can say that they do not want to have their scores used in my research; they can say that they do not want to answer any particular questions in the interview. They can also say later that they do not want to have some of their answers used in my research.

If you are happy to have your child participate in these tasks with me, then fill in the form below,

Yours sincerely,

Ambrose Malefoasi

Informed Consent form

I, ________________________ (father/mother/guardian) give consent for my child, __________________ to do the tasks as outlined above with Ambrose Malefoasi. I understand that the information given by my child in the work sheets and the interview will be kept confidential.

Signed: ____________________

Date: ______________________

Appendix 4. Participants' consent Form

Dear ____________________

I am Ambrose Malefoasi, I come from Malaita province and had been a teacher of Mathematics for the past six years. At the moment, I am doing a Master of Education (Mathematics) at the University of Waikato, in New Zealand.
As part of my studies, I am doing a study about students in Mathematics in the Solomon Islands. The research that I am going to do is on the English grammar and vocabulary and how that influence mathematical word problems solving.
So we will be doing tasks that in vocabulary level, writing and solving of word problems. Each of these tasks will take approximately 30 minutes. After these tasks few of you will be chosen for an interview. I will pick students for interview because you have different scores in the tasks. The interview will take no longer than 30 minutes and another teacher will be present. The interview will be taped so that I can listen to your answers. The tapes will be destroyed after the research is finished.
Your scores and interview answers will be kept confidential-they will not be shared with anyone. You can say that you do not want to have your scores used in my research; you can say that you do not want to answer any particular questions in the interview. You can also say later that you do not want to have some of your answers used in my research.

If you are happy to participate in these tasks with me, then fill in the form attached.

Thank you,

Ambrose Malefoasi

Ambrose Malefoasi has explained everything that we are going to do in these exercises. I do understand that I can stop or skip any question whenever I want and can leave the room if I do not want to participate in the entire study. I am happy to be part of the task and understand that whatever I say in the interview or write in the surveys will be kept confidential.

Name: __________________________

Date: __________________

Appendix 5. Vocabulary level test

Participant's Profile

Please complete the information below
Gender: ______
Form: _____
Province: ______________________
Age: ______
School: ___________________________

INSTRUCTION

This is a vocabulary test. You must choose the right word to go with each meaning. Write the number of that word next to its meaning. Here is an example.

1 business	______part of a house
2 clock	______animal with four legs
3 horse	_____something used for writing
4 pencil	
5 shoe	
6 wall	

You answer it in the following way

1 business	6 part of a house
2 clock	3 animal with four legs
3 horse	4 something used for writing
4pencil	
5 shoe	
6 wall	

Some words are in the list to make it more difficult. You do not have to find a meaning for these words. In the example above, these words are *business, clock, shoe.*
Try to do every part of the test.

---

1 original	____complete
2private	_____first
3royal	_____not public
4slow	
5sorry	
6total	

---

1 apply	____choose by voting
2 elect	_____become like water
3 jump	____make
4 manufacture	
5 melt	
6 threaten	

---

1 blame	_____keep away from sight
2 hide	_____have had bad effect on something
3 hit	_____ask
4 invite	

5 pour
6spoil

---

1 accident	_____having a high opinion of yourself
2 choice	____something you must pay
3 debt	_____ loud deep sound
4 fortune	
5 pride	
6 roar	

---

1 basket	_____money paid regularly for doing a job
2 crop	_____heat
3 flesh	______meat
4 salary	
5 temperature	
6 thread	

---

1 birth	_____being born
2 dust	_____game
3 operation	_____winning
4 row	
5 sport	
6 victory	

---

1 cap	_____teaching and learning
2 education	_____numbers to measure with
3 journey	_____going to a far place
4 parent	
5 scale	
6 trick	

---

1 castle	_____ moving fast
2 guest	_____large stone building
3 mistake	_____trains run on this
4 rail	
5 speed	
6 virtue	

---

1 clerk	_____a drink
2 frame	______office worker
3 noise	______unwanted sound
4 respect	
5 theater	
6 wine	

---

1 arrange	______grow
2 develop	______put in order
3 lean	______like more than something else
4 owe	
5 prefer	
6 seize	

---

1 boil	_____close
2 earn	_____heat water
3 manage	_____get money by working
4 pile	

5 shut
6 succeed

---

1 ancient	_____not easy
2 curious	_____very old
3 difficult	_____related to God
4 entire	
5 holy	
6 social	

Appendix 6. English essay for language and mathematical assessment portfolios

Participant's Profile

Please complete the information below
Gender: ______
Form: _____
Province: ______________________
Age: ______
School: ___________________________

Instructions to students

1. Please read the question carefully and write your answer on the blank page(s) provided
2. You do not have to write your names.
3. If you are unwilling to answer this question you are welcome to leave the room.

Question

Write a short essay about 200-250 words long to answer the question below;
What are the advantages and disadvantages of wantok system?

Appendix 7. Scale used for the assessing the level of students' writing

LEVELS	CRITERIA
1	1. Can write on an extended topic although without the use of sophisticated language resources such as style of expression, advanced vocabulary or idiom. 2. Impact of the writing may be reduced and the message sometimes impeded by basic errors of grammar or vocabulary. 3. Can attempt to organise the writing, but quite frequent weakness of organisation and inappropriate linking of ideas, or weaken and occasionally impede the message.
2	1. Can write extensively, but with only occasional evidence of limited and quite often inappropriately used language such as: • Matching style expression to the topic • The use of advanced vocabulary • The use of idiom. 2. Can communicate meaning or chosen topics although the impact of the writing may be reduced by some quite basic errors of grammar or vocabulary although these do not significantly impede comprehension. 3. Can organise extended writing but weakness of organisation and some inappropriate linking of ideas, tend sometimes to reduce impact.
3	1. Can write extensive and make a positive impact on the reader through sophisticated language resources such as: • The ability to vary style of expression • The use of advanced vocabulary and word order • The use of idiom and/or humour through the use of these resources is not always completely appropriate. 2. Can write impact on the reader only occasionally reduced errors of grammar or vocabulary, which, however do not impede comprehension. 3. Can organise extended writing in generally a sound way, linking most ideas appropriately, with or without explicit linking words.
4	1. Can write extensively and enhance positive impact on the reader through the effective use of sophisticated language resources such as: • The ability to vary style of expression and sentence length for effect • The use of advance vocabulary and word order • The use of idiom and humour 2. Can write with only very rare, minor errors of grammar or vocabulary 3. Can organise extended writing effectively, linking ideas appropriately with or without explicit linking words.

Appendix 8. Interview questions

Participant's Profile

Please complete the information below
Gender: ______
Form: _____
Province: ______________________
Age: ______
School: ___________________________

1. Can you tell me about how you answered the question?

(**Process of understanding and providing solution)**
(Pidgin): Hao iu save talem mi hao iu ansarem question?

2. What was your conceptual understanding about this question?

(**Conceptual understanding)**

(Pidgin):Wat nao iu save abaot kuestin ia?

3. Is the question short, long or very long ?

(**Syntactical complex feature of length**)

(Pidgin): How kuistin ia hemi short, long or long tumas?

4. When the nature of the question is like this, what challenge(s) did it place on you?

(**Extract the difficulty placed by feature of length)**

(Pjin): Taem kuistin ia hem olsem,iu faendem eni samting hati lo hem ?

5. What word in the question is difficult and hard to understand?

(**Identification of any complexity of mathematical vocabulary term or phrase that caused difficulty**)

(Pidgin): Wat word insaed lo question nao hem hard fo understand?

6. What is your understanding of that word or phrase?

(Extract any difficulty/complexity experienced in the mathematical vocabulary used in the question)

(Pidgin): Wat nao iu save abaot datfala word or phres?

7. In the order in which the question is written, did it contribute to any difficulty?

(**Identifying whether word order contributed to the difficulty of the question)**

(Pidgin): Oda lo wods insaed lo kuestin ia hem mekem hati fo iu ansarem kuestin ia?

8. Were the words or phrases in the question, sounded familiar to you?

(**Familiarity of words or phrases/frequency of use of word/experience of students in relation to word use**)

(Pidgin): Iu bin save lukim oketa wods or fres bifoa samwea,lo skul woka,insaed lo mats klas blo iu?