TEACHER USE OF LANGUAGE WHICH HELPS OR HINDERS
UNDERSTANDING OF MATHEMATICS BY
SECOND LANGUAGE LEARNERS

by

KATHARINE L. BORGEN
B.Ed. (with distinction) The University of Alberta, 1968

A THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS

in

THE FACULTY OF GRADUATE STUDIES

Department of Curriculum Studies

We accept this thesis as conforming
to the required standard

THE UNIVERSITY OF BRITISH COLUMBIA

September 1998

© Katharine L. Borgen (1998)
In presenting this thesis in partial fulfilment of the requirements for an advanced degree at the University of British Columbia, I agree that the Library shall make it freely available for reference and study. I further agree that permission for extensive copying of this thesis for scholarly purposes may be granted by the head of my department or by his or her representatives. It is understood that copying or publication of this thesis for financial gain shall not be allowed without my written permission.

Department of Curriculum Studies

The University of British Columbia
Vancouver, Canada

Date Oct. 7, 1998
ABSTRACT

The purpose of this study was to determine some of the factors relating to teacher use of English in the mathematics classroom that senior second language learners identified as helping or hindering to their learning of the subject. Variations of Flanagan’s (1954) Critical Incident Technique and Ginsburg’s (1981) Clinical Interview were employed to elicit information from eighteen students with various linguistic backgrounds to identify aspects of the English language and methods of explanation which they found helpful or hindering in their attempt to understand mathematics in English as second language.

The interviews with the students were audio-taped and transcribed verbatim. Excerpts from the transcriptions are used as examples to indicated the helps/hindrances identified by the students.

Students identified many language related problems which they, as second language learners, have in trying to understand mathematics. These centered around five themes: 1. Vocabulary, both basic and mathematics specific, 2. Need to translate for understanding, 3. Differences in understanding involved depending upon written vs spoken language, 4. Self-consciousness because of inability to express themselves in a second language, and 5. Motivation and interest in learning. Various aspects of each theme are discussed along with methods that may help students deal with them. The helping methods are discussed under the two themes that emerged: 1. Techniques that the teacher could use, and 2. Coping strategies used by the students themselves. Students indicated that while they felt it was their personal responsibility to learn enough of the English language
to cope in the mainstream mathematics classroom, certain strategies used by the teacher or that they employed themselves could help with different problems. Finally, suggestions are given, both for teachers in the classroom to make mathematics more second language learner friendly, and for areas where further research would be beneficial.
TABLE OF CONTENTS

Abstract ................................................................. ii
Table of contents ...................................................... iv
List of tables ............................................................ vi
Acknowledgments ...................................................... vii

CHAPTER ONE: INTRODUCTION ........................................... 1
  Rationale for the study ................................................ 2
  Problems specific to the English language as used
  in mathematics ...................................................... 3
  Changes in the curriculum ........................................... 5
  Purpose of the study ................................................ 6
  Assumptions .......................................................... 7
  Overview of methodology .......................................... 8
  Theoretical Framework ............................................ 8
  Selection of Candidates ........................................... 9
  Limitations of the Study .......................................... 9
  Summary ............................................................. 9

CHAPTER TWO: REVIEW OF THE LITERATURE ......................... 10
  Background .......................................................... 10
  English as a second language learners ......................... 13
  Problems specific to learning mathematics in a second language
    Basic comprehension ........................................... 17
    The mathematics register .................................... 17
    Linguistically related problems .............................. 19
    Effects of language and number systems .................... 23
    Practical or pragmatic differences and their relationship
to culture .......................................................... 23
  Problems in the multilingual mathematics classroom due to the
  expectation of more verbalization and the problem solving
  approach ........................................................... 26

CHAPTER THREE: METHODOLOGY ....................................... 29
  Introduction ........................................................ 29
  Theoretical framework
    Critical Incident Technique .................................... 29
    Clinical Interview ............................................. 30
    Constant Comparative Method ................................ 32
    Reliability and validity of these methods .................. 34
LIST OF TABLES

TABLE 1: Summary of Basic Demographics Data ........................................ 37
ACKNOWLEDGEMENTS

Many people have made this thesis possible. I am only the author.

I would like to thank Dr. Susan Pirie, my thesis advisor, for her support and encouragement throughout the process - from helping me find a topic on which to focus to the completion of the final paper. Thank you, Susan, for helping me realize that it is never too late to start and for helping me have faith in my abilities.

Thanks also to Dr. Bernard Mohan for his advise, encouragement and support. Your positive attitude always gave me a lift.

Thank you to Dr. David Robitaille who stepped in at the final hour without hesitation to read the thesis and to offer advise and support.

Special thanks goes to the eighteen students who gave of their time to talk to me as they neared the end of their high school years. Your interest in making the mathematics classroom a more positive experience for future generations of second language learners is appreciated. Thank you for sharing your experiences with me.

Thanks also to the many other students who were willing to be part of the study but who for some reason were not included. Your interest and concern for others is a compliment to your generation.

Finally, those who gave the most: To my husband, Bill, and my children, Jeffrey, Jennifer and Craig, what can I say? Thank you! Your love, support, understanding, tolerance, patience and encouragement made this possible. I am very proud of you all.
CHAPTER ONE
INTRODUCTION

Identifying and addressing the needs of students in an English speaking mathematics classroom when English is not the first language of the student is a topic currently being researched in many countries throughout the world where English is the primary language of instruction. Much of this research has dealt with students aged 15 years or younger. Little research, it seems, has dealt with students in the senior years of their schooling and who have recently been placed in a situation where they must learn mathematics in English when English is not their first language.

Students who do not have English as a first language are variously referred to as English as a Second Language students (ESL), Limited English Proficiency (LEP) students, or non-English Speaking Background (NESB) students. Each expression has its own contextual meaning. In British Columbia, the expression ESL student usually applies specifically to those students in designated English as a Second Language classes while the expression, LEP student applies to any student with a poor command or a poorly developed use of the English language, regardless of his/her first language. Therefore, for the purpose of this study I have used the more generic Australian expression, non-English Speaking Background student (Clarkson, 1992; Dawe, 1983), which will apply to any student for whom English is not the first language, irrespective of his/her English proficiency.
Rationale for the study

Over the last two decades, there has been an increase in the amount of immigration to English speaking countries from areas of the world where English is not the first language. Canada has received its share of these immigrants. Sanchez (1993) stated that between 1991 and 1995, approximately 21,000 school age children who do not speak English were expected to arrive in British Columbia. This is a significant proportion of the approximately 200,000 school age children in the province. As children from these families have entered the school system with their various levels of education, there has been an increased demand for ESL classes at both the elementary and secondary levels as well as there being an increased number of LEP being mainstreamed into regular classes. Figures from the Vancouver Public School Board which represent student population as at September 30, 1996, indicate that a number of these students have settled in this area. Of the over 57,000 students registered in Vancouver Public Schools at that time, almost half of them (49.1%) were classified as needing English language assistance even if they were no longer in ESL classes. As well, 57% indicated that English is not the language spoken at home. Individual elementary schools reported up to 90% of their students as needing English language assistance and secondary schools reported up to 80% such students (Form 1701, Ministry Data Collection, December, 1996).

It has been my experience that mathematics is one of the first courses into which NESB students are integrated, sometimes as soon as their second day in the school. In an informal article, Kimball (1990) implies that the same happens in other areas of North America and notes that this may be because many people perceive mathematics as being "language free". Lass (1988) suggests that many people think of mathematics as an
absolute with universal symbols making it logical that NESB students could be placed directly into a mathematics class. However, the learning of mathematics requires logical and abstract thinking (van Heile, 1986) and if the language is not properly developed, connections cannot be made. “Language not only functions as the medium of communication between individuals but also enables individuals to think independently” (p. 35). When NESB students do not perform as well as their native-English speaking classmates, it may be the lack of comprehension of the language of instruction that has placed them at a disadvantage, rather than their inability to understand the concepts (Ciancone, 1990; Cuevas, 1991). Research done mostly at the elementary level has indicated that there are various reasons for this, some of which are specific to mathematics.

Problems specific to the English language as used in mathematics

Research has indicated that problems related to the understanding of mathematical concepts by NESB students can occur within a variety of aspects of the English language as used in the context of mathematics. These include:

1. Mathematical register: This refers to specific terms and expressions used in a mathematical context. Their meaning in the mathematical context may be similar to but not identical to their usage in everyday language. Examples are words such as product, integrate and relation, all of which are used in daily conversation but whose mathematical meaning is very precise.

2. Semantics: The order in which the words are used can affect the meaning of an expression and different words or expressions can imply the same concept. This may be obvious to a native English speaker, but not necessarily to a
NESB person. Although "the sum of three and five" and "three increased by five" both imply the mathematical statement "3+5", and "Two lines meet at right angles." and "Two lines are perpendicular." imply the same relationship to a native-English speaker, this is not necessarily obvious to a NESB student. Alternately, the same words or expressions can imply different meanings depending on the context. The word "right", when used in the statement, "Go to the right." could have a different meaning than when used in the statement "That is right." This latter statement could actually mean "the opposite of left" which is the meaning of the first statement, or it could mean "correct", the opposite of wrong. The meaning, for a native-English speaker, should be quite obvious from context, but if a NESB student has not yet encountered the term in the context in which it appears and tries to relate it to the context in which he/she knows the word, confusion could result. To compound the confusion is the fact that a student could get a "correct" angle or a "wrong" angle as an answer to a question, but he/she could not get a "left" angle as an answer.

3. Syntax: The rules which govern the formation of phrases and sentences can create confusion in a language. Combined with the fact that mathematics has a syntax of its own, much more precise and unambiguous than in everyday spoken or written English makes this a problem for NESB student (Scholnick, 1988). The order of the words within a sentence can create problems of a syntactic nature such as in the statement "There are six times as many students as professors." which is often, incorrectly by a mathematical interpretation, written as "6s=p" (Mestre, 1988). Or, consider that statements, "5 take away
3'' and "take 5 from 3'', in which the order of the numbers is the same, but the first means "5-3=2'', which is not equal to the second, "3-5=-2''. However, "5 added to 3'' and "add 3 to 5'' have the numbers in the opposite order, and technically are written, respectively as "3+5=8'' and "5+3=8'' are equivalent expressions. These seemingly inconsistent ideas create problems for native English speakers and, it would seem, that this is likely compounded for NESB students in the mathematics classroom.

4. **Cultural Context:** Mathematical reasoning is based in a cultural arena and understanding is based on context (Adler, 1995). Mathematics, although often thought to be culture free is developed in a cultural context and "if the mathematics is embedded in a context that bears no relation to anything in the student's experience, it is a barrier to comprehension" (Thomas, 1997; p. 40).

**Changes in the curriculum**

In the present mathematics curricula in North America, students are being asked to consider the process used, and to apply creative problem solving techniques, not to simply determine the final answer to a question through numeric and algebraic manipulations. They are being asked to use a variety of approaches and techniques and must thus be able to relate in some manner to the question to determine it's meaning. The meanings that they extract from the question will be the product of their social interactions (Voigt, 1994). Students from different ethnic backgrounds may extract different meanings and the situation presented to them may not be meaningful if they cannot relate to it in the desired manner.
In a situation at the school in which I teach, a group of NESB girls had been asked to do a puzzle in which they had to perform a specific mathematical task to determine the answer to the question "Why was Little Miss Muffet sad?". They asked me for help. They had made a few minor arithmetic errors and had thus extracted some of the wrong letters in the puzzle. I helped them correct their work and they obtained the correct answer, "Because she had lost her whey". They still thought that they had made a mistake because they did not know the story of "Little Miss Muffet", nor did they understand the implied pun on the word "way" or "whey" as they had never encountered the latter term. In this situation, it was not the specific mathematical concept with which they were experiencing difficulty, but rather they could not relate to the cultural heritage. This was affecting their confidence in their ability to do mathematics and their comprehension of the topic under discussion.

Thus, with increased emphasis on problem solving and verbalization of process, NESB students may be placed at a disadvantage in the English speaking mathematics classroom in that they may not be able to put the question into a logical context, or if they can, they may still not be able to verbalize their thoughts into English (MacGregor, 1993; Adler, 1995).

**Purpose of the Study**

The purpose of this study was to have senior NESB students who could be considered as relatively successful in mathematics as evidenced by the fact that they are registered in one or more senior academic mathematics course, and who had been studying mathematics in English for a limited amount of time, identify particular English language interventions or explanations of the concepts by their teachers that they
perceived as having been of special benefit to them in learning or understanding mathematical concepts. They were also asked to consider those interventions or ways of speaking that they perceived as detrimental to their understanding, or which made it more difficult for them to understand the concepts. As the study progressed and it became apparent that NESB students relied heavily on other students for help, these student interventions were also considered as significant factors.

Assumptions

For the purpose of this study, it was assumed that if students could identify situations that they considered as having been helpful/hindering in their learning, that these probably were helpful or hindering in that situation and that if the teacher became aware of these types of situations he/she might be able to change his/her practices accordingly to better help the NESB student understand the mathematical concepts being presented in English. A second assumptions was that strategies that are helpful/hindering for NESB students may well be helpful/hindering for all students.

On initial overview, it appeared that much research has been done at the elementary level on the types of problems NESB students have in doing mathematics in a second language. (Castellanos, 1980; Clarkson, 1992; Garbe, 1985; Miller, 1993; etc.). Much, also, has been stated regarding strategies that can be used to help NESB students who were mainstreamed into an English speaking mathematics classroom (Lass, 1988; Johnson, 1996; Watt & Watt, 1994). Little research, however, was found that dealt with the multilingual, multiethnic senior mathematics classrooms that are becoming prominent in British Columbia, or with what the NESB students themselves see as positive and negative influences on their learning of mathematics in these classrooms. Of particular
interest, then, with the current changes in attitude to the mathematics curriculum, is what language strategies or interventions used by the teacher in the mathematics class appear to the students to have been either beneficial or detrimental to their understanding of the concepts presented in the more language based, process oriented multilingual mathematics classroom.

This study attempts, through interviews with senior NESB students, to determine the areas which the students themselves perceive as problems in learning senior mathematics in English when English is not their first language but is the language of instruction. It also attempts to determine strategies they use to cope with those problems and what strategies they think the teacher could or should employ to make the learning of mathematics in English a more beneficial experience for them as second language learners.

Overview of methodology

A. Theoretical Framework: The methodology chosen for this work was a variation on Flanagan’s (1954) Critical Incident Technique, using the Clinical Interview Method described by Ginsburg (1981) and analyzing data using a Constant Comparative Method (Glaser & Strauss, 1967).

The Critical Incident Technique consists of a set of procedures, to be described in greater detail in Chapter 3, designed to generate descriptive and qualitative data of an experience of an individual (Woolsey, 1989) by extracting particular incidents that have had a significant influence on the situation. This technique was combined with the Clinical Interview (Ginsburg, 1997) in an attempt to identify those language based situations that the students perceived as helpful/hindering in their attempt to understand the mathematical concepts as presented in English. The Clinical Interview is a technique that allows the
interviewer to follow up on the answers and allows the answers to take the lead so as to capture what is hidden behind the immediate appearances of the meaning of a statement (Posner & Gertzog, 1982). Finally, data was analyzed using the Constant Comparative Method (Glaser & Strauss, 1967; Lincoln & Guba, 1985) to determine and categorize the students’ statements.

B. Selection of Candidates: Candidates were selected on the basis of their willingness to take part in the study and on their fit to certain criteria related to first language spoken, language spoken at home, number of years in a school in which English is the primary language of instruction and their placement in a senior level mathematics course.

C. Limitations of the Study: Being exploratory in nature, and using a limited number of candidates (n=18), there was no attempt to generalize, in a statistical sense, from the results of the study. The results, however, identify some situations in which the language and its use by the English speaking teacher in a multilingual senior mathematics class, are seen as being helpful or hindering to some NESB students. It is hoped that these findings can then be used as a foundation for further research and as a basis for improving the learning environment of NESB students.

Summary

With the large number of NESB students in Vancouver secondary schools and with the implementation of the new mathematics curriculum with its emphasis on language, it seems appropriate to explore the linguistic situations or conditions the students themselves perceive as being beneficial or detrimental to their learning of mathematics in the English speaking classroom.
CHAPTER TWO
REVIEW OF THE LITERATURE

Background

The problems associated with learning in a second language have been researched since the early 1900's. Interest in the problem increased in North America in the 1950's with the influx of immigrants with non-English speaking backgrounds (Olivares, 1996). This interest has continued over the years as people with diverse linguistic backgrounds continue to immigrate to Canada and the USA. Reasons for immigration vary from parental choice to give their children a better educational opportunity to refugee status. Each reason will likely affect the students involved differently. However, regardless of the reasons for immigration and the effect that it has on the students, one of the consequences is that many students in schools in British Columbia have already learned to read and write at least one other language before they learn to read and write English. When these immigrant students enter the Vancouver school system, they are placed in an English-speaking environment, sometimes with, and sometimes without the help of transitional ESL classes. The common language of communication and the language of instruction is English.

The naive view that students who know two languages are at a disadvantage in their cognitive ability to learn subject matter has been shown to be paradoxical (Clarkson & Thomas, 1993). Instead, it has been suggested that there are different levels of language acquisition, and that the level of acquisition of a person's first language will affect the ability of an individual to learn in the second language (Cummins, 1979). Cummins
considered the general concept of learning in a second language and has developed a hypothesis based on different thresholds of language acquisition. Briefly, his hypothesis states that there is a relationship between the student’s linguistic development of both his/her first and second language and the ability of the student to learn subject material in a second language.

Cummins (1979) identifies two types of language acquisition programs, and although both involve the use of one language at home and a different language at school, they are very different in their effects on the students involved.

1. Immersion programs: In an immersion program, students are placed in a learning environment in which they have little or no competence in the language of instruction but are praised for any effort to use that language. The teacher is familiar with the student’s first language and can respond both linguistically and culturally to the student but chooses to use the immersion language since the purpose of the program is for the student to become fluent in both oral and written communication in the new language. The importance of the student’s first language is recognized in that, after a few years of studying in the immersion language, the first language is introduced as a school subject and some other subjects are also taught in it. Examples of this type of program would be the French Immersion programs that arose in the 1970’s in English speaking Canada and the Mandarin Immersion programs recently initiated in Vancouver. Students are usually registered in these programs because of parental desire that they learn a second language. The language of the home and the community is usually the student’s first language (in the cases
mentioned, English) and is the language he/she will be exposed to in the media, but is not the language of instruction in the school.

2. Submersion programs: In a submersion program, although it would not likely be so classified, students are placed in a classroom where there may be a mix of linguistic backgrounds and they are taught in a language in which they have little or no competence. Unlike the immersion programs where credit is given for attempting the new language, “Their lack of proficiency in the school language is often treated as a sign of limited intellectual and academic ability” (Cummins, 1979; p. 225). Students may be frustrated by a lack of ability to understand instruction, and the teacher is unlikely to understand the student’s first language and/or the cultural expectations and heritage. This is the situation in which many immigrant students find themselves. The language spoken in the home is usually the student’s first language, and it may or may not be the language of the community in which they live. Also, there may or may not be other students in the class with whom the student can communicate in his/her first language. Media presentations in the student’s first language are limited or non-existent. The student’s first language is often discredited and English is considered paramount.

Language development, both first and second, are important in cognition. As a theoretical framework for discussing the relationships between these two, Cummins refers to three types of bilingualism:

1. Semibilingualism: At this stage of bilingual development, the individual has a low level of language acquisition in both his/her first and second languages.
There may be a balance in the level of acquisition, or one may be dominant, but both are below standard. The second language may have a 'subtractive' effect on the first language, in that it is may be gradually replacing it. In this case, there is a negative cognitive effect on the ability of the person to acquire knowledge in the second language related to lack of competence in either.

2. Dominant bilingualism: If a person has a 'native-like' competence in one language and a less adequately developed second language, he/she is classified as dominant-bilingual. Cummins claims that the cognitive effect on learning ability in this case is neutral.

3. Additive bilingualism: The individual in this classification has a high level of competence in both languages being considered and the result, Cummins (1979) claims, is that there is a positive cognitive effect on his/her ability to learn in either language. The individual is able to transfer information freely between the two languages, adding to his/her cognition in both.

"The key to understanding the educational outcomes of a variety of bilingual education ... lies in recognizing the functional significance of the child’s mother tongue in the development process" (Cummins, 1979; p. 236). That is, the level of development of the child’s mother tongue is a significant factor in the his/her ability to understand in a second language.

**English as a second language learners**

The process of learning another language requires not only learning the vocabulary, but also the learning of new feelings and methods of conceptualization (von Glasserfeld, 1995). Students studying in a second language have a knowledge framework
based on what they know in their first language as well as what they have learned in their second language. Their perceptions and understandings are based on social, cultural and linguistic understandings and serve as their frame of reference (Johnson, 1996). NESB students in Vancouver are likely faced with different perceptions and references than the native Vancouver born student. Also, not only must they learn a new language and study in that language, but they may also often face a cultural conflict. Some may be living in a community in which their first culture is practiced, whereas others are placed directly into the North American culture. In either case, the home environment is likely to maintain first culture practices whereas the school emphasizes the North American pedagogical methods and cultural perspective (Malone & Miller, 1993). The student may be torn between his/her traditional way of interpreting the environment and the one presented in the school with some inconsistencies resulting. Spolsky (1986) states that there are four barriers to second language learners receiving the same educational benefits as the first language learner: “first, that their language is not the same as the language of the school; second that their regional or religious or ethnic dialect is not that of the school; third that their social dialect is different from that favored by the school; and fourth, that their socially or culturally determined preference for verbal style is different from that cultivated by the school” (p. 188). These will affect the NESB student’s ability to learn in the school. These same concepts are confirmed by Johnson (1996) when, in discussing second language acquisition in a classroom, she notes a framework around which understanding communication in second language classrooms can be interpreted:

1. Teacher control of the patterns of classroom communication.
2. Students' perceptions of the patterns of classroom communication.

3. Students' knowledge and use of language.

4. Students' use of language for classroom learning and second language acquisition.

Teacher control of the patterns of classroom communication is accomplished through the way he/she structures the classroom, the form of questioning used and/or the use of intonation to guide answers to control content. It is influenced by aspects such as his/her professional knowledge, theoretical beliefs and past experiences with second language learners. As the teacher may be one of the few native speakers of the language of the classroom, he/she may be held in an elevated status as a source of information on correct speech patterns (Johnson, 1996).

A student's perceptions of what is appropriate behavior and forms of communication are based on his/her prior experiences and knowledge of the language of instruction. Problems may arise if these perceptions are different from those of the teacher (Johnson, 1996). One such problem may occur if the teacher can communicate with some of the students in their first language, while not with others. The latter perceive this as giving an unfair advantage to the students with whom the teacher has a common language, even though the teacher sees it as a way of helping those particular students understand the concepts better (Goldstein, 1997) and not at all discriminatory.

Students' use of language will be guided by their knowledge of the language. They "enter classrooms with an accumulation of prior experiences and knowledge through which they interpret the world ... language [is] the medium through which they represent their experiences..." (Johnson, 1996; p.13). Second language learners must learn the new
language as well as the coding system through which to make it make sense. If they are not able to communicate in the pattern of the classroom, there may be erroneous assumptions regarding their intelligence (Johnson, 1996; Troyna & Siraj-Blatchford, 1993). Clarkson and Thomas (1993) state that “Academic proficiency is more than being able to converse fluently in the peer group which is usually acquired within two years. The language skills needed to operate effectively in a classroom take much longer and must be acquired across all subject areas. In many areas, including mathematics, the only opportunity that bilingual children will have to learn the language of the subject will be the classroom” (p. 269). Thus, while the language in the various classrooms that a student attends may be the same, English, it is specific to the subject matter being studied and previous language knowledge will play an important role in understanding the technical terms as applied to a specific subject area (Frid, 1993).

Problems specific to learning mathematics in a second language

The process of learning mathematics involves the abstraction of ideas from words used in context (Miller, 1993). Students studying mathematics in a second language face many problems, some of which are similar to those faced by first language learners, but some of which are unique. Since “teaching involves frequent communication between teacher and student. When the dialogue is conducted in a language unfamiliar to the student, difficulties are likely to arise” (Dale & Cuevas, 1987; p. 10). The problems faced by second language learners of mathematics may be general to all NESB students, or may be specific to a single linguistic base, depending upon the “linguistic distance” between their first language and English (Dawe, 1983) or on the cultural interpretation of the
process of mathematics of the student involved (Frid, 1993). Some of the general problems are discussed below.

1. **Basic comprehension**: Lack of reading comprehension of the English language is a major source of difficulties for students in doing mathematics in English when English is not their first language (Olivares, 1996). Many of these difficulties are linguistically based, and not based on a lack of mathematical understanding (Clarkson, cited in Garaway, 1994). Simply stated, the problem is that often the student does not understand the words being used or if he/she does understand each word individually, problems may arise because of the way in which the words are put together. Cuevas (1984) states that “The student who comes from a home where English is the only language spoken will be familiar with many of the linguistic structures to be encountered in the mathematics classroom. One cannot make the same assumption for the second-language learner” (p. 139). Similarly, “those privileged to have the same language at home, in the school, in the work place and in the mass media get reinforced from different sources (Pattanayak, 1986; p. 13). Reading comprehension involves not only knowledge of the vocabulary, but also knowledge of the structure of the language. Relational words, such as “more” and “less” and their related concepts such as “longer-shorter” and “wider-narrower” play an integral part in understanding of mathematical concepts. The inability of NESB students to put them into the correct context can lead to delays in comprehension (Jones, 1982).

2. **The mathematical register**: Lack of understanding of the English vocabulary is amplified in the mathematics classroom by the fact that mathematics has its own register (Pimm, 1987). A vocabulary exists which is specific to mathematics and which
is given precise meaning in that context and “manipulation of this vocabulary becomes
vital for understanding the teacher’s explanation in class and for solving word
problems” (Dale & Cuevas, 1987; pp. 12-13). NESB students, in trying to apply
meaning to the vocabulary in a mathematics classroom often look at the base of the
term used and will extract a contextual meaning for it related to their experience
(Garbe, 1985). This meaning often comes from a non-mathematical context and can
lead to confusion for the NESB student in his/her attempt to understand the
mathematical concept. Examples include “factor” and “factory”, which have been
confused by younger students, or for senior students the term “field” which has a
mathematical meaning totally unrelated to the term as used with respect to farming.
Alternately, although a native English speaker may see the relationship between the
mathematical meaning and the everyday meaning of a word such as “intersection”, an
NESB student may not see similarity between the “intersection of sets” and the
“intersection of two streets”. Thus, confusion is created as a result of transfers of
meanings across everyday language and mathematical language. Johnson (1996) and
Moschkovich (1996), refer to this as a “discontinuity” in the student’s understanding
of concepts across registers and this discontinuity is compounded when there are two
or more languages involved. Whether or not the everyday language usage of a word is
a help or a hindrance to the understanding of a mathematical concept will be
dependent upon “the extent to which the students’ integrated everyday language with
technical terminology or symbols in ways congruent with the corresponding concepts”
(Frid, 1993; p. 35).
Students learning mathematics in a second language may need time to translate (Clarkson, 1996; Whang, 1996). If the linguistic base of a student’s first language is very different from English, the necessary term may not exist in the student’s first language as is the case with many aboriginal languages (Jones, 1982; Nathan, Trinick, Tobins & Barton, 1993; Gibbs & Orton, 1994). In the Hausa language of Nigeria, no word exists for triangle, and in the Sinhala language of Sri Lanka, all four sided figures are referred to by the same term (Gibbs & Orton, 1994). Alternately, it may be that confusion results due to translations which can lead to seemingly contradictory statements (Castellanos, 1980).

Within the general framework of language, “sound alike” words create problems for NESB students across registers. Navajo children confuse terms such as “quotient” and “patient” or “addition” and “audition” (Garbe, 1988). Confusions of this sort decrease with the age of the student, but the preciseness of the meanings of mathematical terms can still create problems for NESB students at higher levels (Gibbs & Orton, 1994).

3. Linguistically related problems: The structure of the English language, or the way the words are put together can create special problems for NESB students in a mathematics classroom. Structure involves, not only the way words are put together to give meaning, but also the fact that the same thing can be implied by different statements (Sinclair & Coulthard, 1975).

a. Syntax: The order of words and the grammatical connections between them give meaning to words or phrases in any language, and give special meaning in subject specific areas such as mathematics (MacGregor, 1993). Mathematical
notation also has a syntax of its own which controls the order and combination of symbols and which allows for a very precise and unambiguous representation of information (Scholnick, 1988). However, even the mathematical notation is not universal. It has been observed that students of different cultures will use spaces, commas, or periods to separate large numbers into groups of three as a means of distinguishing place value. Similar grammatical structure in English can lead to meaningless phrases if the structure does not provide for correct mathematical interpretation (MacGregor, 1993). The expressions “nine times slower” and “twice as less” have similar grammatical structures, but the latter lacks the mathematical interpretation of the former where the “nine times” implies division because of the “slower”. “Twice as less” does not provide a similar mathematical representation of “twice” and “half”. This kind of situation creates problems for NESB students both in interpreting the mathematical ideas and in expressing their own ideas (MacGregor, 1993). Similar expressions arise in the use of “Black English Vernacular” (Orr, 1989). This type of misinterpretation seems to occur when the grammatical structure of the language is not understood.

The order in which words appear in sentences can create problems in the interpretations of meanings of mathematical concepts (Mestre, 1988). “A number added to 7 equals 18.” is generally interpreted correctly, but “In 7 years John will be 18.” lacks the same structure and a specifically denoted
variable so that students have a more difficult time interpreting it. Also, problems may occur within the mathematical structure itself since reading is not necessarily done left to right, but can be vertical or on a flow chart (Olivares, 1996). Other problems occur due to logical connective such as “if-then” and “or”. Garaway (1994) points out that the difference between the inclusive and the exclusive “or”, which would be obvious to a native-English speaker, could confuse an second language learner. A native-English speaker would understand the question “Do you want hot or cold meat?” to be exclusive, one or the other. The non-native speaker might simply answer “Yes.” in that he/she does want one or the other, not the vegetarian dish.

MacGregor (1993) illustrates how seemingly insignificant little words can alter the meaning of a mathematical expression with the following five examples: “take one-third of, decrease by one-third, decrease to one-third, one-third less than, less than one-third” (p. 56). A simple “is” deleted between the “five” and the “more” in “five is more than three” creates an entirely different meaning to the phrase. Brodie (1989) states that “Knowledge of logical connectives and indeed of sentence structure in general is very important for learning mathematics and yet might not be easily accessible to children learning in a second language” (p. 47).

Semantics: Variations on the meanings of words in context can create problems for students with limited English proficiency (Gibbs & Orton, 1994). In the mathematics register, different words can imply the same operation, as in addition being implied by phrases such as “increased by”, “more than”,

b.
"combine" or "sum". Also, in context, different operations or concepts can be implied by the same words. (MacGregor, 1993; Mestre, 1988; Jones, 1982).

Pirie (in conversation, 1997) noted that in the statement, "five multiplied by three", the "by" is associated with multiplication, but in "five increased by three" it is associated with addition whereas in the statement, "a five by three rectangle" the "by" does not imply any operation. Also, expressions in context can become semantic units, but the words in the expression can create cross register confusion. Pimm (1987) notes that such is the case with the expression "reduce a fraction to lowest terms" where the purpose is to leave the fraction with the same value, not the customary meaning of "reduce" which would mean to make smaller. Jones (1982) states that relational words are also seen as a significant problem for NESB students since "such terms are often complex in meaning in that the same word can be used in a variety of contexts to signal different mathematical relationships" (p. 270). For example, the words "more" and "less" are important in elementary mathematics, but the mathematical interpretation often depends upon the context in which the words are used. Confusion may be compounded across languages when two different English words may be translated to the same word in the student's first language. Such is the case with "side" and "edge" which have significantly different meanings in English in relation to a cube, but are translated to the same word in some Papua New Guinea languages (Bishop cited in Brodie, 1989). Similarly, problems occur when no word exists in the student's first language and a word is "borrowed" which has a related meaning, but not
precisely the mathematical concept implied (Pimm, 1987). Such is the case with the Swahili term “ulalo” which literally translates “longest of all” for the English term “diagonal”. Olivares (1996) notes that in some cases, the NESB student may simply overlook some of the smaller words as insignificant or may not see the connection that is implied because of the order of the words.

4. Effects of language and number systems: Although the binary system may be mentioned with respect to computer language, the number system generally used without question in English speaking classrooms is the base-10 positional system using the Hindu-Arabic notation. This can create problems for students from cultures which use different notational systems or different methods of counting. (Saxe, 1988; Gudlach, 1989). For a native English speaker, “8” and “eight” convey the same meaning but to many NESB students, there is nothing inherently the same about the two. Students from countries such as China or Japan must learn a new notation system as well as the vocabulary. For others, such as some aboriginal peoples who use various body part as counting devices and do not have a written numeration system, the situation is even more confusing. (Ascher, 1991). Still other problems are created by the fact that we still embody some other base systems in our culture, such as base 60 in time and angle measure or base 12 as in a dozen eggs.

5. Practical or pragmatic differences and their relationship to culture: The role of context in understanding and in the interpretation of meaning of a mathematical statement is significant (Spanos, Rhodes, Dale & Crandall, 1988) and can affect classroom performance in terms of strategy, styles of processing information, preferences for dealing with the concrete or the abstract, and many other areas (Leap, 1988). Santon
(1994) states that mathematical terms are often couched in a mathematico-technological language and that some implied meanings will be readily available to the native speaker of the English language because he/she is cognizant of the linguistic structure, but that for NESB students whose linguistic base is different, problems can arise. As mentioned earlier, Cuevas (1984) agrees that one cannot assume that a non-native speaker of English will make the same interpretation of a statement as a native English speaker would make. Simple direct translations may even lead to contradictions for students with a Hispanic background and as noted previously, notational devices can create problems as well. (Castellanos, 1980). A student will identify with the environment and initial relationships will be made through the use of his/her first language. Language is a tool with which we try to instill into students an understanding of mathematical concepts. However, “the natural structures and classifications that we impose upon our world will be different for speakers of different languages” (Brodie, 1989; p. 43). Words are rooted in the historical and physical community of the individual, and this can result in students of different cultural and linguistic backgrounds abstracting differently (Nathan et al, 1993). Kerpert (1993) states that mathematics can best be understood in a cultural setting and “language develops our thoughts and shapes our understanding of the environment” (p. 275). Mathematics is present in every culture, but interpretations or emphases may be different providing different structures and forms of classification for students from different cultures. However, most mathematics textbooks, especially those designed for use in an English speaking classroom, are designed for the mathematico-technological society and present concepts and “real life” situations from a western
point of view. This can create problems for students who have a different cultural background and who cannot relate to the situations (Leap, 1988). Aboriginal children in Central Australia have a strong sense of cardinal direction, but have little need to count. On entering an English classroom in which the emphasis is on precision, they have a difficult adjustment (Graham, 1988). Ute Indians have a difficult time relating to mathematical “real life” situations. Instead of abstracting the idea, they answer questions based on their truth-value analysis of the situation (Leap, 1988). In an English speaking mathematics classroom, then, these students must learn a new language, as well as learn new ways of interpreting their environment. “Culturally learned ways of communicating that differ from those expected in school can create discontinuity between the home and the school, and ultimately inhibit students’ abilities to fully participate in and learn from classroom events” (Johnson, 1996; p. 61). Berry (1985) points out how different values can create apparent mathematical inconsistencies in some third world countries. The lack of usage of large numbers in the Setswana language does not mean an inability to keep track of large numbers of cattle. Instead, the language is rich in its descriptive form of each animal, and one “knows” when one cow is missing just as one would “know” if a certain uncle were missing from a family photograph. It would seem that “learners who speak a different language from the language of learning are not simply disadvantaged by a lack of proficiency in the language of learning, but much more by cultural processes entailed in and through language intersecting with the difficulties of all learners with access to the English mathematical register” (Adler, 1995; pp. 264-265).
Problems in the multilingual mathematics classroom due to the expectation of more verbalization and the problem solving approach

In the present context, a multicultural, multiethnic or multilingual classroom are considered to be one and the same in that if various cultures are represented, so also will be various linguistic and ethnic backgrounds. Von Glasserfeld (1995) notes that although words are used to communicate ideas, their use does not guarantee understanding. The understanding of a concept comes from personal experience. These experiences and the means of abstracting from them will vary for different cultures as well as for individuals within each culture. As we have seen previously, mathematics has a language of its own, its own register. However, mathematics must be learned through a language and in a multilingual mathematics classroom where the teacher may be one of the few native speakers of the language of instruction there may be a tendency to minimize the use of language. With the current emphasis on language in the mathematics curriculum, and the move away from rote memorization and symbol manipulation to a more language based model (NCTM Standards, 1989) this is not a viable solution. As Hiebert and Carpenter (1996) state, “Evidence suggests that the learners who possess well-practiced, automatized rules for manipulating symbols are reluctant to connect the rules with other representations that might give them meaning” (p. 78). Thus, the second language learner who performs mathematics by use of rote memorization of rules is further separated from an understanding of the concepts in that he/she is likely not to make connections with the environment. Pirie & Kieren (1994) believe that the process of learning mathematics involves a folding back to previous levels of understanding. If a student’s relationship to the environment or method of abstracting meaning is different from that presented in the
classroom, he/she may experience difficulties in the folding back process in that it may lead to confusing or contradictory results or there may be nothing in the folding back process with which to relate. Added stresses are thus placed on the teacher and the students in their attempt to verbalize their understanding of the situation or the concept. With second language learners, this can create an extra problem if the necessary vocabulary is not available or the perspective is different. Students from various cultures are being put together in a mathematics classroom in which the presentation is from a western perspective with examples and approaches to situations also taken from that perspective. Dawe (1983) noted that while sociolinguistic difference between the student’s first language and English is important in understanding mathematical concepts, their ability to abstract in their first language is of greater importance. “Language not only functions as a medium of communication between individuals, but also enables individuals to think independently” (van Hiele, 1986; p. 35). It would appear that if a student cannot integrate his/her abstractions in his/her first language with those in English, a true discontinuity will result.

The language learned for mathematics is best learned in context. That is, it is best learned while doing mathematics, but that learning can be interrupted in a multilingual classroom when the different perspectives are not understood or appreciated. This can involve cultural attitudes to gender related issues, work ethic and outlooks on authority and relationship to elders. If a student comes from a culture in which there is strong emphasis on respectful, non-questioning attitudes, the learner may not be willing to question the teacher or ask for another explanation. A student from a different culture may prefer discussion over written work (Begg, 1993). Both these attitudes can create conflict
with respect to the expectation of more verbalization and the problem solving approach prevalent in the present day British Columbia mathematics classroom.

It was with these ideas in mind that the study was initiated. The literature relating to the methodology chosen for this study will be reviewed in Chapter Three.
CHAPTER THREE
METHODOLOGY

Introduction

The methodology chosen for a study and the method used to analyze the data are crucial to obtain usable results. In this chapter, I will review literature related to the methodology chosen for this study and include a brief description stating why each technique was considered suitable in this instance. A more detailed description of the actual study and the way in which the methods were applied will follow.

Theoretical Framework

A. Critical Incident Technique: Flanagan’s (1954) Critical Incident Technique “outlines procedures for collecting observed incidents having special significance and meeting systematically defined criteria. [An incident is] any observable human activity that is sufficiently complete in itself to permit inferences and predictions to be made…. To be critical, an incident must occur in a situation where the purpose or intent of the act seems fairly clear to the observer.” (p. 327) and where there is little doubt that it has affected the situation. Woolsey (1986) describes it as “a simple interview procedure for collecting information from people about their direct observations of their own or others’ behavior” (p. 243). The Critical Incident Technique is often used in situations where it is necessary to call on memory for the data (Flanagan, 1954) and has been used in looking for incidents, or real situations that have been significant, or have had an identifiable affect on the situation.
The Critical Incident Technique was chosen as a method for this study because the intent was to have students identify specific methods or situations in which the wording or language used in the presentation of a mathematical concept by the teacher had a definite affect on their ability to understand a particular concept in mathematics. Flanagan (1954) states that “if suitable precautions are taken, recalled incidents can be relied on to provide adequate data for a fairly satisfactory first approximation of a statement of the requirements of the activity” (p. 340). It was hoped that in the analysis of the incidents collected from the NESB students involved in the study, patterns of speech or methods of explanation that the students perceived as being helpful/hindering would emerge and that these would then be able to be used in the future to improve the learning environment for NESB students in an English speaking mathematics classroom. Woolsey (1986) states that “Critical incident studies are particularly useful in the early stage of research because they generate both exploratory information and theory or model-building” (p. 252).

B. Clinical Interview: The Clinical Interview (Ginsburg, 1997) is based on the methods of Jean Piaget and can be thought of as a directed or a professional conversation (Posner & Gertzog, 1982). “Its chief goal is to ascertain the nature and extent of an individual’s knowledge about a particular domain by identifying the relevant conceptions he or she holds and the perceived relationships among those conceptions” (p. 195). The Clinical Interview allows one to gain insight into many aspects of the student’s mind by using a semi-structured, open-ended type of questioning and allows the student’s answer to direct the next question (Ginsburg, 1981). The interviewer starts out with some common questions or statements, but future questions are modified based on the student’s response thus allowing the interviewer to follow up on the students’ leads and to let those leads
determine the further questioning (Posner and Gertzog, 1982). This must be done, however, in a context of trying not to direct the student’s responses (Ginsburg, 1981) or to elicit what Piaget referred to as suggested convictions (Posner and Gertzog, 1982). They state that there is “real danger in the possible misinterpretations of responses [and that] Piaget recommends that the examiner make countersuggestions after a short lapse in the interview” (p. 197). Ginsburg (1997) supports this by suggesting that it may be necessary for the interviewer to occasionally give what he/she assumes are incorrect interpretations of what the interviewee means in order to ensure that the student is not responding in a manner which he/she assumes the interviewer expects.

Although the Clinical Interview allows freedom in questioning, a certain degree of standardization must be maintained if one wishes to obtain usable results. This is done by having an original task in mind, open-ended as it might be (Ginsburg, 1981). The interview should be guided by prepared questions with the first statement setting the stage for the direction of further questioning but allowing for freedom to probe for further explanations. Woolsey (1986) makes a similar point regarding the collection of statements of critical incidents when she states that it is best to use “simple everyday language to convey an obvious meaning” (p. 244) since this statement will direct the students in the type of incidents they are likely to report. However, “If one set of instructions does not induce the child to understand a problem in the intended manner, then a clarification of instructions or even a new set of instructions may be required” (Ginsburg, 1981; p. 9), but since “a slight change in the wording may produce a substantial change in the incidents reported” (Flanagan, 1954; p. 341) the interviewer must be cognizant of different meanings that may
be attached to different words and explanations and how they might be interpreted by someone who has a poor command of the language (Ginsburg, 1981).

While the Critical Incident Technique allows for some freedom of questioning, the Clinical Interview seemed to provide a better forum for obtaining information from NESB students since English would be the language of communication, but not the language of choice of the student involved. It was felt that NESB students might not be able to express their thoughts clearly on a first try, and the interviewer might have to probe more deeply by redirecting and rewording questions and answers in order to clarify the student’s meaning and the interviewer’s understanding of the answer while trying to be sure not to misrepresent the student’s intent.

C. Constant Comparative Method: The Constant Comparative Method (Glaser & Strauss, 1967) for analysis of data is consistent with Flanagan’s Critical Incident Technique of analysis, but like The Clinical Interview, it also allows for more flexibility. In using the Constant Comparative Method, data analysis is often done at the same time as the data is being collected. Conrad (1982) summarizes four stages of the Constant Comparative Method of data analysis as:

1. collection and coding of data.
2. comparing data with properties of concepts that have been abstracted during the comparison
3. continuous analysis and further refinement of their relationships, and
4. presentation of a theoretical discussion.

“The constant comparative method is concerned with generating and plausibly suggesting (but not provisionally testing) many categories, properties and hypotheses
about general problems” (Glaser & Strauss, 1967; p. 104). As such, since no proof is involved, data need only be collected until saturation is obtained. It is customary, in a Constant Comparative analysis of results, as with Flanagan’s Critical Incident Technique, that data is analyzed and coded into categories as the categories emerge (Glaser & Strauss, 1967). One begins with a small sample of incidents to form initial categories and new data is fitted in or new categories created as needed. As the process is “more subjective than objective” and requires “insight, experience and judgment” (Flanagan, 1953; p. 344) on the part of the person analyzing the results, corrections and reclassifications may take place during the analysis. A category is considered saturated when further incidents do not add new information. Woolsey (1986) notes that in some situations specific incidents can be categorized, while in others, descriptions of relationships may be used or, at times, a theoretical framework may be needed to make the data comprehensible.

This method of analyzing the data was considered applicable to this study in that the study is a first step in determining the types of language based incidents that senior NESB mathematics students identify in the English speaking mathematics classroom as being helpful/hindering to their learning and understanding of concepts. Each interview could be analyzed independently and on its own merit and student statements could be classified as indicating helps or hindrances. As well, they could be reviewed and reclassified, or multiple-classified as analysis continued (Glaser & Strauss, 1967). They could then be further analyzed as to what type of help or hindrance they were and similar incidents could be clustered together to form refined categories.
D. **Reliability and validity of these methods:** Anderson and Nilsson (1964) using a number of different methods, in various studies, concluded that the Critical Incident Technique is a valid and reliable method of collecting and analyzing data. In a series of experiments, they determined that a relatively small number of incidents are needed in order to form a saturating group of categories, and that the number and structure of incidents was not greatly influenced by using different interviewers.

Ginsburg (1997) states, with respect to the Clinical Interview, that “just as one must determine separately the reliability of each individual test, so is it necessary to determine the reliability of the Clinical Interview as used in each particular investigation” (p. 169). He cites examples, however, that indicate that there is an acceptable amount of inter-observer reliability, alternate form reliability, test-retest reliability and internal consistency and further that “these forms of reliability are not necessarily crucial criteria for sound research [especially if] the investigator is dealing with strategies that normally vary within individual children” (p. 174). With respect to validity, he states “Perhaps the very factors which degrade the reliability of the clinical interview - the flexibility of the interview procedure and the complex responses it elicits - are precisely those that enhance its validity” (p. 175). He dismisses the importance of content criterion validity to the clinical interview but notes that the clinical interview can be valuable because it has been used successfully over a long period of time.

**The study**

A. **Introduction:** The study was designed to collect information from a group of relatively successful NESB students regarding what and how the use of language in the English speaking mathematics classroom helped or hindered them in their ability to understand the
concepts presented. The setting for the study was a Vancouver Secondary School with a population where over 80% of the students were identified as needing extra help due to their poor command of English. Thirteen home language groups, other than English, were identified as being spoken by six or more students in the school. As well, there were thirty-six students identified whose home language was spoken by fewer than six students.

Clinical interviews were used to collect information from the students regarding incidents in the English speaking mathematics classroom which they had found helpful or hindering to their learning of the material presented, and these were analyzed using The Constant Comparative Method for classification.

B. Selection of participants: Senior mathematics students in the school involved were made aware of my interest in the topic of language in a multilingual mathematics classroom through informal discussions both in and out of class. Once the design was in place, and I had obtained permission from both the school and the university by way of the principal signing The Administrator Informed Consent Form (Appendix A) and the University’s Behavioral Research Ethics Board Certificate of Approval, I spoke to all mathematics 12 classes in the school during one of their regularly scheduled classes to explain the purpose and the process of the study in more detail. Students were assured that their standing in the class and the school would in no way be affected by their participation or non-participation in the study. I explained that each student registered in a mathematics 12 class would be issued an identity number regardless if he/she participated to help maintain confidentiality and Informed Consent Forms for both the students and their parent/guardian (Appendix B). They were requested to return the signed forms even if the student or his/her parent/guardian indicated that he/she would not be interested in
participation. When a student returned his/her Informed Consent Forms indicating that he/she was willing to participate in the study, he/she was issued a Demographics Form (Appendix C). Only the student’s identity number, and not his/her name, was written on the Demographics Form in order to maintain anonymity in selection of candidates. Students were asked, on their Demographics Form, to choose a pseudonym. These were cross referenced with their names to arrange for interviews, then the pseudonym was used in the interviews. The pseudonyms were later changed as were the names of any individuals specifically mentioned in the interviews for the purpose of further maintaining anonymity and confidentiality.

Participants were chosen on “the basis of their relevance to the research problem” (Conrad, 1982; p. 244). More specifically, participants for this study were chosen according to the following guidelines:

1. They were perceived as being relatively successful in mathematics due to the fact that they were registered in at least one mathematics course at the grade 12 level, although they did not necessarily have to be passing the course.
2. English was not their first language and it was not the language spoken in their home.
3. Their elementary schooling was completed in a non-English speaking environment. This meant that most of the students would have studied mathematics in English for less than five years which placed them below the number of years suggested by Cummins (1979) as being the time necessary to master technical or professional language.
<table>
<thead>
<tr>
<th>Student Number</th>
<th>Country of Origin</th>
<th>First Language</th>
<th>Number of Languages Spoken</th>
<th>Number of Years in an English School</th>
<th>Language of Preference for Mathematics</th>
<th>Grade Level</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-1</td>
<td>Hong Kong</td>
<td>Cantonese</td>
<td>4</td>
<td>3</td>
<td>English</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>3-2</td>
<td>Hong Kong</td>
<td>Cantonese</td>
<td>3</td>
<td>4</td>
<td>Cantonese</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>4-3</td>
<td>India</td>
<td>Punjabi</td>
<td>3</td>
<td>3</td>
<td>English/Punjabi</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>6-4</td>
<td>India</td>
<td>Punjabi</td>
<td>3</td>
<td>3</td>
<td>English/Punjabi</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>10-5</td>
<td>Japan</td>
<td>Japanese</td>
<td>2</td>
<td>2</td>
<td>Japanese/English</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>11-6</td>
<td>Taiwan</td>
<td>Mandarin</td>
<td>2</td>
<td>3</td>
<td>Mandarin</td>
<td>12</td>
<td>21</td>
</tr>
<tr>
<td>5-7</td>
<td>India</td>
<td>Hindi</td>
<td>3</td>
<td>3</td>
<td>Hindi</td>
<td>12</td>
<td>19</td>
</tr>
<tr>
<td>7-8</td>
<td>China</td>
<td>Cantonese</td>
<td>3</td>
<td>3</td>
<td>Cantonese/English</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>2-9</td>
<td>India</td>
<td>Punjabi</td>
<td>3</td>
<td>2</td>
<td>English/Punjabi</td>
<td>12</td>
<td>18</td>
</tr>
<tr>
<td>15-10</td>
<td>China</td>
<td>Cantonese</td>
<td>3</td>
<td>2</td>
<td>Cantonese</td>
<td>12</td>
<td>20</td>
</tr>
<tr>
<td>17-11</td>
<td>Ethiopia</td>
<td>Amharic</td>
<td>2</td>
<td>2</td>
<td>English</td>
<td>12</td>
<td>19</td>
</tr>
<tr>
<td>16-12</td>
<td>Hong Kong</td>
<td>Cantonese</td>
<td>2</td>
<td>8</td>
<td>English</td>
<td>12</td>
<td>19</td>
</tr>
<tr>
<td>18-13</td>
<td>China</td>
<td>Cantonese</td>
<td>2</td>
<td>2</td>
<td>Cantonese</td>
<td>11ESL</td>
<td>17</td>
</tr>
<tr>
<td>9-14</td>
<td>Macau</td>
<td>Cantonese</td>
<td>2</td>
<td>3</td>
<td>Cantonese</td>
<td>11ESL</td>
<td>17</td>
</tr>
<tr>
<td>12-15</td>
<td>Taiwan</td>
<td>Mandarin</td>
<td>2</td>
<td>4</td>
<td>Mandarin/English</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>13-16</td>
<td>China</td>
<td>Chinese</td>
<td>3</td>
<td>1</td>
<td>English</td>
<td>11</td>
<td>19</td>
</tr>
<tr>
<td>14-17</td>
<td>Vietnam</td>
<td>Vietnamese</td>
<td>3</td>
<td>10</td>
<td>English/Vietnamese</td>
<td>12</td>
<td>17</td>
</tr>
<tr>
<td>8-18</td>
<td>China</td>
<td>Chinese dialect</td>
<td>5</td>
<td>8</td>
<td>English</td>
<td>12</td>
<td>18</td>
</tr>
</tbody>
</table>

Of the students indicating willingness to take part in this study, eighteen were initially chosen to be interviewed. Although it had been hoped that the sample would be multilingual and multiethnic, all those who indicated willingness to participate and who initially appeared to meet the criterion, were of an East Indian or Asian background. During the interview process, I observed that three did not technically meet with the
criterion as set out above in that they had been in an English speaking school in
Vancouver for eight years or more. Two of these were not used in the analysis, but I
retained the third one when I realized that he was used in class as a translator by several of
the other participants. His input, I decided, would be beneficial. Of the sixteen participants
included in the study, seven different first languages were represented.

C. Data Collection: Interviews took place over a three week period in May, 1998, which
was near the end of the student’s school year. Each candidate was interviewed individually
at a time that was mutually convenient to the candidate and me. Interviews lasted from
thirty to forty-five minutes and were audio-taped so that they could be listened to later.
Audio-taping was chosen over video-taping because it was considered less intrusive and
would make the students less self-conscious than video-taping would have. Audio-taping
was also considered less distracting and more accurate than note-taking.

Each interview began with a preamble similar to the following, reminding the
student of the purpose of the interview and to put him/her at ease.

Hi, X. Thanks for coming. As you know, from our earlier
discussions, what I’m interested in is how the English language
as used in the mathematics classroom can help you or can make
it more difficult for you as a second language learner to understand
the concepts presented. I’d like you to think of any times that
something the teacher has said or a way he or she presented things
that have helped you or made it harder. Any kinds of things the
teacher says or does that makes things easier or harder. Do you
have any ideas on that?

After this initial introduction, consistent with the Clinical Interview methodology,
questions and comments were contingent on student responses, guided by a series of
questions (Appendix D) identified as being significant to the study. While some students
arrived at the interview with clear ideas concerning problems they experienced in the
English speaking mathematics classroom and strategies that they found useful or that they thought the teacher should use, others needed prodding and these questions were being used as a guide. As it was difficult, at times, to understand the meaning of a student’s statement, I found it useful to summarize what I understood them to mean. This proved to be an effective method to clarify meaning in that often the student had had a hard time expressing him/herself or a word would be missed because of the rate at which the student spoke or my misunderstanding of a term. Students would disagree or agree with my interpretations and expand on the ideas.

After a few initial interviews, my thesis advisor and I listened to one tape and discussed the process and student responses to determine if changes should be made. Since the Clinical Interview process appeared to be being followed and as I was eliciting useful responses, the format was maintained.

D. Analysis of Data: Initially, my intent was to use the audio-tapes of the interviews directly to extract the incidents. This proved to be more difficult than anticipated as student responses were often difficult to understand due to strong accents and poor grammar so I had the tapes transcribed. Since “One advantage of working with tapes is that vocal nuances are not lost, as they are on transcripts” (Woolsey, 1986; p. 248), I then listened to each tape to ensure that the transcripts were verbatim and to correct any errors. Once corrected, the transcripts were again read while listening to the tapes. In this way, while coding the transcripts, I was able to “hear” what the student said and, I believe, it gave me a better understanding of what each student meant.

Due to the fact that the interviews took place over a short period of time I decided not to begin the analysis until all interviews were completed although I did listen to some
of the tapes. Also, since one interview often set the stage for the questioning and
discussion of the next, I decided that it would be best if they were analyzed in random
order. This was a departure from the Constant Comparative Method, but it was used so
that I did not approach the analysis with a particular mind set and so that saturation did
not appear prematurely due to some of the directed discussions.

During the process of the analysis, I chose three tapes at a time, followed the
above procedure for ensuring correct transcriptions, then began coding. I first read
trough a transcript, numbering any comments made by the student or segments of the
interview that seemed to indicate that the student was identifying a help or a hindrance to
his/her learning mathematics in English. Once coded, these identified segments were then
divided into the two groups: helps and hindrances. Each group was then considered
independently with statements of hindrances being considered first. Each segment was
given a descriptive label identifying the type of problem noted by the student.
Commonalities were then noted. The hindrances were then labeled and grouped according
to their commonalities and descriptive labels attached to the groups. When it was observed
that some of the problem groups identified were similar to those identified in previous
studies, similar labels as those used in previous studies were given for convenience of
identification and discussion.

In considering the help statements, two themes emerged: the student’s own coping
techniques and suggestions for teacher interventions. The help statements were divided
into these two themes and each was handled in a manner consistent with the hindrance
statements. After analyzing twelve interviews, saturation seemed to have been reached for
both help and hindering statements. The thirteenth interview was analyzed and it was
noted that no further themes emerged. The themes that had already been identified were re-examined as to their identifying traits, and the remaining three interviews were coded to determine if new concepts arose and/or to see if all incidents could be fitted into existing categories. No inconsistencies occurring, no further interviews were conducted.

The findings of the above analysis are discussed in Chapter Four. Transcriptions of segments of the interviews are given as examples of each identified theme.
CHAPTER FOUR

RESULTS

Introduction

In this study, eighteen senior NESB students were interviewed in an effort to determine those language situations in the mathematics classroom which the students identified as being helps or hindrances to them in their attempt to understand the concepts presented in English when English was not their first language. The interviews were audi-taped and then transcribed for better understanding. In reviewing the transcripts and listening to the tapes of the interviews, comments and/or interview segments were identified and separated into two categories: helps and hindrances. Each category was then treated independently with the hindrances to learning mathematics in English as a second language being considered first. During the analysis of the helps category, two themes emerged: students identified coping strategies which they personally found useful and, in addition, they gave suggestions of ways they thought the teacher could operate the class to make it more second language learner friendly.

The purpose of this study was to determine how teacher use of the English language in the mathematics classroom helped or hindered understanding of mathematics by second language learners and I feel that the three themes identified represent a broad overview of this purpose. Problems identified by second language learners are considered as hindrances to their ability to learn mathematics in English as a second language whereas coping strategies and suggestions to teachers are helps to learning mathematics in English as a second language. It should be noted that in stating their coping strategies, or in giving
suggestions to teachers, students are not directly relating a problem they have, but in essence are indicating situations that they find problematic. Similarly, if one looks at the problems identified by the students, one may be able to determine methods of teaching that would alleviate them.

In the following section, hindrances to learning mathematics in English as a second language as identified by students, as well as the coping techniques and suggestions to teachers, are discussed under the various category headings identified during the analysis of transcriptions of interviews conducted. Excerpts of student’s statements are given as examples of the themes. Every attempt has been made to ensure that student responses are accurately interpreted and that the quotes are verbatim. Punctuation has been inserted only when and where it was obvious or apparent. No attempt has been made to correct the students’ grammar. Three dots (...) are used in the transcripts to indicate that a portion of the statement has been omitted and three dashes (---) to indicate that there was a pause of significant length. In cases where the student began a word, but then changed to a different one, the assumed intended unfinished word is written in italics in brackets (italics) after the abbreviated form of the word. Each quote is also identified by a number which indicates the student’s interview position and the position at which the tape was analyzed. That is, a 5-3 indicates that this is a quote from the fifth interview conducted and that this interview was in the third position for initial analysis.

Hindrances to learning mathematics in English as a second language as identified by second language learners

Problems which students identified within the mathematics classroom are considered hindrances to their learning of mathematics. When the problems have a
language base, they are considered hindrances to their learning in English as a second language, not withstanding the fact that some of these problems may also be problems for students whose first language is English. Originally, twelve problem categories were extracted from the data, but on closer examination, they merged into five: vocabulary, translations, written language vs spoken language, self consciousness, and motivation and interest.

The five problem areas overlap and are intertwined in a complex way but are thought to be different enough to require separate discussions. As well, some students had problem areas that others thought were helps as opposed to hindrances. Interconnections and contradictory statements will be discussed in Chapter 5.

1. Vocabulary: There were several ways in which students indicated that vocabulary, or lack of appropriate vocabulary in English, was a problem. Initially, some students identified this by referring to the rate or speed of the presentation or teacher talk within the classroom.

"Um, like one teacher, some teachers talk really fast so that’s also a speaking cuz like ESL are not used to listen when people talking like that fast so that’s also a bit problem." (4-3)

"...Some people ask a question but they speak so fast I don’t understand what they are asking.” (10-5)

"... I don’t know, you were going slow, I don’t know but it was fast for me because it was totally new thing ... so you were a little bit faster for me, so.” (5-7)

Rate of speech, however proved to be much more complex than just the speed with which the teacher spoke or presented material. It involved the student’s
understanding of each term as well as their ability to process the meanings of groups of words when put together to form a phrase or a sentence. These problems will be described under four headings: English vocabulary, mathematics register, syntax and semantics.

a. English vocabulary: Included under this heading are statements where students indicated that they had problems in mathematics because of their lack of basic English vocabulary and skills. Also included are statements that refer to the “higher level” of the language used by the teacher compared to that understood by the students as well as the opposite of this, the use of slang. If students cannot understand the basic terms used by the teacher or the definition they know for a word did not “fit” into the statement presented by the teacher, as well as the fact that some words are culturally understandably to native English speakers but not to second language learners, creates misunderstanding and confusion.

“Yes, because I think that the Chinese has a good background of math but they don’t know how to use it, the English. That’s the major problem.” (3-2)

“But sometimes like with a word problem there’s some kind of word I never like heard before and like that kind of troubles like I don’t understand.” (4-3)

“. . . and you will use a high vocabulary which is just over my head because I don’t know those words, right, so its, sometimes it gets harder for me to understand like what you are saying and what the question is asking. . . . Ya because that’s your daily language right, but that’s not our daily language because we just know the normal English words, right, and you are used to the high vocabulary and stuff so you just use your daily language but its harder for us to understand.” (5-7)
“Um, --- How to say? Ummm --- Okay, when the teacher say contra, contradic, contradiction. Yah. Then I have confusion about what is contradiction mean. Ya. Like contradiction, like for for for a Canadian it is like they can understand it. But for second language student maybe think like what is contradiction mean, like, ya, they use that confusing for me.” (3-2)

“No, like, when they speaking, like some times people speaking they not used, they may not use the formal words, like they say something, I don’t know, like metaphor. They try to say a thing, but its like ugh. They they the way they say it’s not formal English is sometimes I get confused, ya. (Interviewer - So if they, okay, if they’re not using formal English ---) “Speaking English like is different from ---” (Interviewer - Right, right, so they’re sort of using almost slang type words.) “Ya, like if you say ‘What’s up?’ I don’t like, if I I’m not living here for a long time, I don’t know what even is “What’s up?” mean.” (3-2)

“Sometimes I don’t understand the vocabulary, like you know, what was problem talking about. Like one time I was trying to solve the problem but it was talking about the ‘ship’ or something --- then I was, I got lost and I didn’t understand. I used dictionary but I still didn’t understand what the problem was.” (10-5)

“I think the teacher uh have have, maybe not very help us when we you don’t understand the concept and the teacher uh come and talk the question. Sometimes Mr. Mr. Y tell me teach me and I don’t understand to him either because when when he talking I don’t understand what he talking.” (15-10)

“I’m listening to you but I don’t know what you are saying. I know what you are saying, like, but I’m listening but I’m not understanding what you are saying, right. ... I’m looking everything but I can’t understand you.” (5-7)

“Ah, I think the most important thing is the vocabulary because actually sometimes I don’t understand the questions sometimes. Just I can’t understand the questions so I don’t know how to do it.” (18-13)

b. Mathematics register: Included in this category are statements in which the students indicate that it is words specific to mathematics that they do not
understand. The word may be entirely new to them and they are not able to relate it to anything they know, or they may be familiar with the word in a different context, and when they see it in a mathematical context, they define it in their minds as they know it but get confused about what is being asked because the definition they are applying to the term does not create a logical connection. Thus, questions or instructions involving those terms leave them at a disadvantage because they cannot extract the correct contextual meaning from the sentence.

"The thing is I, like have to, okay, know the language, like, if you say what’s the difference between this, right? And if we use that in like math it has a different meaning, right. So I get sometimes confusing it because when I learned the English right before I learned the English, like I learned the vocabulary, words difference means this or that, right but if we see it used in math it means like a little bit different.” (5-7)

"Cuz I don’t usually ask what a word means, and uh, ya, right.” (1-1)

"Like, umm, the the word meanings. If I choose the wrong meanings then I will cannot maybe connect all questions together.” (11-6)

"Things like umm, I don’t know cuz the language of math maybe is different like English and some kind of subject.” (11-6)

"Okay, you know ‘differentiation’, actually it means like difference between two things, right, like you’re actually like comparing two different, you’re comparing two thinks like if Inder say different shape between me and Raj, right, then it means like we’re comparing something, right, so if it comes in math I will say ‘What shall I differentiate?’ like, um, the same meaning is in my mind, like I have to compare something, right, but it’s not in the math, it’s something different, isn’t it?” (5-7)

"Okay, like in math we use pie, right which value is twenty-two over seven. If you talk pie, pie just a pineapple pie, apple pie, right. See that’s totally different. Like if you will draw that pie thing I would remember once, right, pie that pie. So okay in math we use this as a pie like this but if like you know like not a smart person like doing a word problem would say the pie value is this, I will okay, draw a pie and I will say that this pie value is this
cake pie value is like 22 or something like that you know...” (The spelling kept as pie instead of pi as this seems to be the source of confusion. The ‘pie thing’ seems to be referring to the Greek letter.) (5-7)

“Like, --- oh when does a straight line become like a tangent like you know, like I look at a textbook --- indicated which one is tangent right, and I didn’t understand what the tangent was.” (10-5)

c. Syntax: Syntax refers to how the words of a language are put together to make meaning. Many students identified that they could understand each word in a sentence but when they put them together, they could not extract the meaning of the sentence or they simply could not understand what was being asked.

This problem occurs most often in the context of “word problems” and involves the use and placement of prepositions and connectives or “little” words that can greatly alter the meaning of a phrase. These words are often overlooked by second language learners who are concentrating on the bigger picture or on key words. Included in this category, then, are situations in which students did not necessarily see a problem, but the problem became more apparent when I purposefully altered some statements to determine if the student understood them. It also includes situations in which students recognized that any word not understood correctly could totally alter the meaning of the problem.

“I, I think people who first they have to know the English then they can, like, they can’t directly like, some, they have to know ell like basic English to have the math. Then they can start. Like if they haven’t studied math in English before, then they have to - like you can’t explain words like ‘what’ and ‘and’ and what ‘here’, ‘there’ means in math so they have to know that.” (6-4)

“Ya, I don’t think the words themselves are not hard to understand. It’s when they combine that’s, when they combine into one sentence it’s very
difficult to understand and connect everything, you know, to reach a decision.”
(Interviewer: So each individual word is okay.)
“It’s the whole thing combined like that — like just solve if AB is this long and that is BE and like if BC is this long and that is DE and then half as long as, twice as much as this kind of stuff. It’s confusing.” (17-11)

“The grammar, like, the whole thing was hard, like the grammar because for me when we write an essay, like, we have lots of errors like in grammar so if grammar doesn’t make any sense the sentence like useless.” (3-2)

“Like if I don’t understand this one word in the word problem and I think it isn’t important, sometimes it is important, its some weird thing like tells the line should be straight for example, right, ... so it makes a difference.” (4-3)

“... but the problems and you have to read over them more than three times for them understanding.”
(Interviewer - And when you’re reading them over, what kinds of problems are you having in understanding them? Can you sort of identify the kinds of things you have to look for?)
“Um, because it’s in English and different from my language and so the sentence structure, you have to read over because I am going to school and my answers like school I am (indecipherable comment) . You have to understand it, what’s that mean and make sure not some misunderstandings.” (7-8)

(Interviewer - Okay, now when you’re reading some of the English in the math textbooks, there’s a lot of little words in there, ‘of’ and ‘at’ and ‘by’) “Ya, its hard!” (10-5)

(Interviewer - Okay, how about if we say something like ‘five is more than two’ and ‘five more than two’?)
“Five is more than two?”
(Interviewer - What does it mean?)
“Five is more than two --- mean five --- it mean five is greater, the number is bigger than, --- or the number is two bigger than five?”
(Interviewer - Okay, let’s think of the second one, ‘five more than two’.)
“Five more than two, --- I think is seven.”
(Interviewer - Okay, so what does five more than two mean?)
“Five more than two mean the --- the number is --- umm umm --- it mean five plus two.”
(Interviewer - Okay, now think about five is more than two. In English, what?)
“Ah!! Meaning five is bigger than twol” (10-5)
"Ah, slowly, like I read it again and again, ya, because like when you like for example is easy, I am taller than you right, like this number is bigger than another one so I have to think about which number is bigger, ya, when I, okay, when I see the word biggers I mean I have to know what word is the biggest unit and then that number and that number and then I have to struggle which one is." (3-2)

"...it's hard to first read the mathematic problem in words then put in algebraic thing..." (2-9)

"I will keep reading it if I will understand one thing then the next thing doesn't make sense to me right, so everything looks totally different. I will say, okay, this makes sense with this but it doesn't. This word shouldn't be here, right. So that makes me more confused." (5-7)

d. Semantics: Different ways of saying the same thing or different words that can be used for the same object or idea were identified as a problem for second language learners in mathematics. If a concept is expressed in one way by the teacher and then a different explanation is given, the second language learner may not realize that the two are referring to the same thing or are simply different methods that can be used to solve the same problem. Related to this is the fact that some words sound the same but have different meanings depending on the context and sometimes the spelling. Students identified that as second language learners they have a difficult time extracting the correct meaning for these terms and the meaning of the sentence is lost if they extract the wrong definition.

"Because you know um um English if if one word have many different meanings, yeah, then I have to think which meanings I have to use when I see the word." (11-6)

"But it, I will feel confuse because I learn two ways to do one question ya so I don't know sometimes it make very confuse. Ya." (11-6)
“No, I’m English has a lot of different meanings.”
(Interviewer: Yes, and what way does it have a lot of different meanings? Um, what do you mean it has a lot of different meanings?)
“Um, like sometime the vocabulary change you know in a different sentence --- and I, How to explain? But sometimes its change the meaning.”
(Interviewer: So you’ve got the same word, )
“Ya, but I want to understand from which meaning I should use.” ..... 
(Interviewer: What if I told you the two words ‘go to the right’ and ‘right angle’? Do you understand the difference in those?)
“Go to the right and right angle, I think so.”
(Interviewer: What is a right angle?)
“Right angle is --- is that right angle is ninety degrees or something.”
(Interviewer: Um hum. And what would you do if I said ‘go to the right’?)
“Go to the right, go to the right.” (Points)
(Interviewer: Okay, what if I told you --- it is perpendicular?)
“Perpendicular is the two lines never ever touch, no?”
(Interviewer: Perpendicular? Two lines never touch?)
“No, no, no wait like how do you say, ya ---
(Interviewer: What do you know about the angle?)
“Angle is ninety degrees.”
(Interviewer: Which is what kind of angle? (laughter) --- It’s a right angle.)
“Oh, Ya!”
(Interviewer: So we have two different words there that mean the same thing, right. So that, and perpendicular and parallel you were mixing up.)
“Ya, they both start with ‘p’.” (10-5)

“Ya, tricky words, in English one word has a lot of different meaning. In Japanese, one word, I mean there are a lot of different ways to say the words.” (10-5)

2. Translations: This section considers the types of problems students identified when they used translations from one language to another. Translations may involve consulting a dictionary, particularly if there are no other students in the class who share the same first language, or discussions with fellow students with whom they share a common language. Students identified different kinds of problems associated with each of these scenarios. They may need extra time to translate or they may not be able to identify with the word or concept even after it has been translated because they
cannot relate it to a meaning in their first language. As well, translations of individual words within a sentence can lead to nonsensical statements. Two special situations are noted: one where the student does not want to translate as it will only cause confusion, and a second where the student tries to rely on a third, very inadequately understood language in order to create a meaning for herself.

"In English I think I need more time to think about questions" (11-6)

"...the English we have to, like you know, we translate to Chinese and say it in Chinese, like the Cantonese, right, because when you are in like I have some friends like she's going here, like, when we speak with her in Chinese she, Okay I get the Chinese thing and then she translate to English first and ya, is all same thing we hear in our language and then you have to translate it to your own language you know how the problem." (3-2)

"Um, ya, I don't mix up the mathematic words and general um words but actually even if I try to find the word you know in Japanese dictionary, I find the word however I don't understand the meaning. So even if I don't mix up I still have hard time trying to understand the words." (10-5)

"Like, uh, I don't know like real terms like how to say in Punjabi or Hindi." (6-4)

"But each word has their own definition in a dictionary. If you put all those definitions together sometimes it doesn't make sense so, ... sometimes it doesn't translate exactly so its a little bit off. By the time you have like 20 words in that sentence, it would be way off." (Interviewer: Get quite a different meaning.) "Exactly! And it would it's very time consuming to translate that, to actually do that in a test." (16-12)

"[I have trouble translating] in Mandarin times because the grammar is different ... Like uh like uh when we say when we say the address you know we have to say the number of the house first then the street but in my count (country) in my language I have to say the street first then the number. Its the opposite." (11-6)

"Because if you do good in algebra, so that's not a problem. The problem is when you have to relate from the, getting algebraic thing from the word problem, that's the problem." (2-9)
“Ya, I don’t want to know [in my first language] because its kind of confusing when you see same thing in two languages like same two words for same thing, its kind of confusing. I don’t want to even if someone tells me that this is what you call it in Punjabi. This word in graphics and what not. I would I would not memorize it you know.” (2-9)

“Sometimes my friend says ‘Oh sorry I don’t know how to explain to you.’ And I’ve said ‘Oh that’s ---’ Explained to me, right but she tried to explained to me and she tried to explain which Chinese, include Japanese use Chinese character so she put some Chinese character and sometimes I can understand sometimes I don’t, right, and finally I said that’s okay maybe you know I’ll do it in my home. It’s hard.” (10-5)

3. Written vs spoken language: Students identified that they experienced different difficulties depending on if the language was spoken or written but that understanding of the spoken word usually preceded understanding of the written word within the mathematical context. However, this did not mean that they always understood the spoken language, and often individual words were not be heard. Textbooks, which use a formal and very concise language, create problems in that some second language learners in this study who indicated that often they could not extract meaning of the sentences. This is similar to the previously mentioned situation when teachers use a “high” vocabulary. Students also expressed concern over their own written and oral work, being unable to express what they mean and thus having it misinterpreted by the teacher.

“I understand --- the teacher talking uh is better than just I read the book.” (15-10)

“Yes, uh, sometimes in class I understand what what he talking. Ah, after school when I when I was looking in the book I I don’t understand that.” (15-10)

“Some sometimes uh if if the teacher uh did not write on the board uh he just talking I don’t understand what is that.” (15-10)
“Sometimes like mostly I try to listen to the teacher, like if I don’t get it then I’ll see what he’s trying to say like whatever he writes on the board so it alternate with this but the first thing I try to listen.” (4-3)

“Ya, like the rea (real) like when I translate it English is okay for me but when I speak it was hard. I can usually understand what the teacher says in class, ya, but when I have to speak up it’s maybe difficult like I have to ask a question.” (3-2)

“…she always gave me the thing that I don’t want it but I really struggling about the thing, she comes and she can’t give me the real answer because I can’t express what do I really don’t understand.” (3-2)

“I don’t know but I think if you can understand me that’s most help but actually sometimes I ask you, I don’t know how to ask, right.” (18-13)

4. Self-consciousness: As well as not being understood by the teacher as mentioned above, inability to express themselves properly in English creates two other problems for second language learners in the English speaking mathematics classroom. Students indicated that they are reticent about asking a question because they are embarrassed by their lack of knowledge of the English language and because they fear that others will laugh at them because of their poor English. Students also indicated that they were concerned about “holding back” the English speakers in the class and felt that it was unfair to those English speakers if the teacher had to spend extra time explaining things to the second language learners.

“Because my English is not very good maybe they will misunderstanding what I talking about.” (11-6)

“Ya, I find it, cuz like if one person in the class right, he asks ‘Oh I don’t understand this meaning’ he would feel uncomfortable cuz other people might know the meaning of that, just you’re the one that don’t know, right. So I think ESL students might not ask the questions because everyone will think ‘Oh she doesn’t know English word”’. (4-3)
“And one more thing like you know sometimes the students who does not have their first language as English right, they don’t speak in class much because other students they are boring you and they know better English and especially me what I feel, right, cuz I’m going to say something, if I was to say something in a wrong tense or something, if I were to say something wrong you know the people will laugh at me right. So that’s a thing, too, people don’t speak up in class and like when the math teacher is explaining and they don’t understand they will not say ‘No I didn’t understand’ because they are scared of others like others will make fun of that person, that he’s speaking or she’s speaking the wrong English or stuff like that. Because that happened to me when I came here in ESL right, so um, I took the some, you know, ESL program, so I didn’t know how to borrow a pencil, right, in English because I had never talk in English so I said to a girl like ‘May I had borrow your pencil?’ Something like that because I never knew and she started laughing at me and like it was so, I felt so guilty like I don’t know this thing and I shouldn’t have speak out, right. So and that makes me too, sometimes if I will not understand but I don’t know how to ask you, like because I don’t have words like how should I put that together and ask you, right. So that makes me, too, not to ask the questions in the class, too, right, you know, sometimes. ... Ya but I don’t know like its just a scary, kind of a scary thing like you know they know good English and they will make fun of you and that makes scary you know ---” (5-7)

(Interviewer - Are you really comfortable speaking English all the time?)
“Not all the time. Sometime. No”
(Interviewer - What situations would make it difficult, do you think?)
“In public.” (6-4)

“... well I think that they may like I think the teacher can like because in a classroom there is many people can speak like can speak fluently English, right, the teacher can like use some simple words to talk, to teaching the class, it would be boring, right, ...” (3-2)

“Uh, uh, waste waste too much time, right? So, uh, for the other classmates is unfair. They understand that. Why you talking so much about eas easy word? Just for ESL classmates who don’t understand that and we need that.” (15-10)

5. Motivation and interest: Lack of motivation to learn English and/or mathematics was identified as a problem by students in trying to learn mathematics in English as a second language. Students who were not willing to put in the effort to learn the
necessary English were seen to be at a disadvantage as they would be held back by the need to translate and by lack of understanding of what is said in the classroom.

"Ya, it depends I think seventy percent it depends on the student when he or she want to learn it." (2-9)

"Um I think if if um if it depends it depends on the person itself. If the person is really um, really um keen on learning then they would pick up very fast because they listen they um they would repeat it in their mind and they can practice and they use it when they are at the time." (1-1)

"Well, but then it would be up to the students to decide if they want to actually learn it or not, so." (16-12)

Helps to learning mathematics in English as a second language as identified by second language learners

Students identified strategies they themselves found helpful while learning mathematics in English as a second language and they also gave suggestions about methods or techniques they thought could or should be used by the teacher to help them better understand the mathematical concepts when presented in English when English was not their first language. Their coping techniques are useful in the context of how teacher language helps students learn mathematics in a second language in that they indicate what the student does with the English language to help him/herself create meaning of concepts in English when it is not his/her first language or their language of choice and provide hints as to how the teacher might change the presentations to make the concepts more understandable. The suggestions regarding methods which might be employed by teachers to help second language learners better understand the mathematical concepts when they are presented in English are a direct link to students' perceptions of how they can have a
more beneficial experience in the English language mathematics classroom. Although not all suggestions are directly related to how teacher use of language helps second language learners in the mathematics classroom, I felt that there is a connection between any activity in the classroom and the teacher's use of language.

1. Coping strategies: Coping strategies used by second language students learning mathematics in English varied greatly and depended on such factors as whether there were other students in the class with the same first language but whose English was better than the individual’s English and whether the individual had studied the concept previously in his/her first language. Many students indicated that they felt that it was their personal responsibility to learn enough of the English language to cope in the mathematics classroom, and not the responsibility of the mathematics teacher. They indicated that if they did not understand enough English, they would not be able to function in a mainstream mathematics class and there was very little the mathematics teacher could do to help.

“I think I have to learn by myself to understand English word.” (11-6)

“I think there is really, time the student has to spend on their like improve their English that is the first thing student has to do.” (3-2)

“Umm, I thought it’s my English problem so I say I have to improve my English as soon as possible, right, so I have to push myself harder and harder and so I have never found teacher that can help you know.” (10-5)

“Um, hum, um. So I think we have to learn the English first. We - the the teacher cannot help help us too very much you know. He he just the math teacher no the language teacher.” (15-10)

“I have to work on it. Not the responsibility of the teacher. I need to read more.” (17-11)
“Not really because if they don’t understand English that well, they can’t understand basically everything, you know basically what you teach them they won’t, they can’t, if they can’t understand what you’re talking about, then I don’t know how they can understand it.” (16-12)

While indicating that they needed to have a working knowledge of the English language to cope in the mainstream mathematics classroom, students identified various coping techniques they used to help themselves in this situation. Themes developed around the themes of translations, visual representations and patterning.

a. Translations: Translations could work in two ways: from English into the students first language or simply using the English vocabulary because no acceptable meaning could be found in the student’s first language.

i. Some relied on a dictionary to find either the word or its meaning in their first language while others relied on translations and explanations by fellow students with whom they shared the same first language but whose English was better than their own. Students would think through the problem in their first language or would discuss it with their friends in their first language.

“Basically it’s only one or two vocabulary words I don’t understand in one session, so I will just look up from the dictionary, then the rest I can do for myself.” (7-8)

“I think the classmates are very important. They can help me to improve. ... Find the dictionary to look up meaning or asks (ask) someone.” (11-6)

“I tried to guess it and if I cannot guess it I look up the dictionary I still cannot get it I will ask my friend.” (10-5)

“... I always sit with some people who can speak English more, like as a first language and when I have something I don’t understand from the teacher like just ask them and she can explain. ... Ah ya, I do math with a
lot of other students because ya when they ask me question and I may ask them questions we always ask each other questions. Not only in Chinese but maybe English the other way too.” (3-2)

“Ummm both. Sometimes if I real under (really understand) really don’t understand I I will talk to my brother or my cousin and then I think in my Cantonese uh some easy question I can I can think about in English.” (15-10)

“I think ummm if if we have we have many classmates like so uh and we something some person eh say us the same language which we we umm umm we can we can try ta talk the problem together.” (15-10)

“I’m a tutor in Tutor Club but there is, with some students from ESL classes that come there they can do the questions but they need to explain the instructions that are given in the question in Punjabi, so that’s why, that’s the only reason why they come to tutor class, to get help in the same language that they speak.” (2-9)

“When I’m in class I do speak Cantonese.” (18-13)

ii. Students indicated that if they had already studied a given topic in their first language they tend to retain the first language terminology involved with it and often found the concept easier to understand because they could relate to it in a more understandable way. When a new term is introduced, however, and no acceptable term or meaning can be found in the individual’s first language, he/she tends to incorporate the English term into his/her repertoire and learn a meaning that is acceptable, through explanation by another student.

“Ya. Like sometimes thinking in another language works, like when I am adding or subtracting or multiplying in my head like without a calculator sometimes its easier to add in Punjabi not in English, not always, sometimes I do that. … I mean I have a few ideas why - I think it might be because you learned that stuff in that language.” (6-4)
“Ya because most of them I have done in Japan so it will better understand the vocabulary I was able to solve the problems.”
(Interviewer: But in math class when you get a new word you would, do you tend to think of it in Japanese also? When you look it up in your dictionary, do you still think of it in Japanese?)
“I try to do that before but, --- I couldn’t understand the meaning because I have never done in Japanese so it didn’t help me at all.” (10-5)

“No, not really we we always use Man Mandarin to describe a questions because we learn some of them the questions in my country ya so its easy to me to understand.” (11-6)

“... in math actually if they have done math in their own language then it’s easier ... but they don’t know how to say in English.” (6-4)

“Um, for me I think a math word is like, a word I have to remember.” (3-2)

“Yes, cuz I, I, I, I don’t know the Chinese translation of the words, say derivative, like. I don’t know and I just use it use derivative because I first learned it in Canada.” (1-1)

(Interviewer: You say you get help from your sister at home. When you talk to her, do you work in English or Punjabi when you’re doing your math?)
“Both actually. Ya like it depends on our mood I think. If we were talking with our parents before starting our homework and stuff like that so sometimes we speak in Punjabi but sometimes in English too. In school usually English.”
(Interviewer: Right. Um, when you’re speaking in Punjabi do you have the mathematical terminology in the Punjabi language? Do you know mathematical terminology?)
“No. I use English.” (2-9)

“Because I can’t translate those technical terms back in Chinese.” (16-12)

“Well when I first time I heard it I totally didn’t understand it and then I just remembered the method how to calculate it how to use it and I won’t bother to find the real meaning in Chinese. Like just like and I heard the word ‘calculus’ I won’t try to find my own meaning like on my Chinese word for calculus. I just know there’s a thing called calculus, ya.” (3-2)

“I take help from Mandeep, right. She will explain me, if I don’t understand a meaning of a word she will say me, this is this word and that is the
definition and that mean that right. She will explain me and I will say 'Ya, okay I'll have to use this word and that means that ---.' " (5-7)

b. Visuals: Many students indicated that they would use diagrams or graphs to try to make meaning of questions or situations presented. If an equation could be found or was involved in the question, this would also be of assistance.

"Cuz the way she explained it, it was totally related to the diagram that we see ...." (2-9)

"Well I just keep these words in my mind as pictures like I imagine in my mind one ellipses like that so I just you know remember that like the shape of that thing or by whatever I think of one I'll know how it looks like." (4-3)

"Ya, well in geometry last term you showed me a diagram, you explained the sentence in a diagram and that I understood." (18-13)

"Yes, with the word problems, right. When I see the word problems I can’t like think in my mind like what they’re saying so I have to draw a picture cuz that would explain it me, ya, lie (like) not just reading them the words." (4-3)

"I think it’s be easier from visual than theory, that’s what I think, for me it’s easier that way, visually than theory would be best." (17-11)

c. Patterning: Students indicated that they would often copy work done by the teacher and would then try to do other questions using the same procedure.

This generally occurred in the context of problem solving, especially when the student did not understand the wording of the question or could not make meaning of it through translation. They indicated that if they could identify the unit the question came from, they could apply a procedure from that unit simply because they knew that was a process that could be used in that section.
“... when I’m listening to a lot of example, when teacher explain almost the same thing over and over, right, I can tell what they are talking about so I think I need more exercise.”

(Interviewer: And when the teacher’s going through examples, more and more examples, what’s happening that’s making it easier for you do you think?)

“Maybe I can understand the pattern.” (10-5)

“Um, like I if I could write the questions on the board I have to redo them those questions.” (11-6)

“That’s right, just like in calculus, okay, right now when I look at the question I know this question is asking about calculus so I guess, what can I do in calculus just like write down a problem or I forget what it’s called, and just do the thing, right.” (18-13)

2. Suggested techniques for teachers: Students gave many suggestions of methods they thought that the English speaking mathematics teacher could use to improve the learning environment for second language learners. These centered around the actual vocabulary used and the way in which it was used, the method of presentation and the general organization.

a. Language of presentation or actual vocabulary used: Although, as indicated earlier, students generally felt that it was their own responsibility to learn the English language well enough to function in the mathematics classroom where the language of presentation was English, they did suggest some methods and techniques that could be used by the teacher to help them develop their mathematical register and to better understand the significance of various parts of speech or the significance of specific words as used in the mathematics classroom.

i. Vocabulary lists: Students indicated that to help them improve their
mathematics register a vocabulary list with definitions could be presented at the beginning of each unit along with a list of any new symbolism that would be involved in that unit. Written definitions could be given in technical terms, but should be accompanied by verbal explanations in which the teacher used “easier” words or by diagrams if possible. Some students suggested that vocabulary should be associated with student experience with the difference between the “everyday” meaning of a word and the meaning in a mathematical context being indicated.

“Mr. X, he usually puts the harder terms and on the board and explains them, like a definition, like literally terms and stuff like that so it’s the same thing so it really helps when he puts the terms, mathematical terms on the board”

(Interviewer: On the board and he defines them?)

“Ya, defines them before even beginning the chapter. … He puts the terms same as the book does but he explains them in simple language so that kind of helps …” (2-9)

“… like in the beginning they should tell us like these are the symbols is going to be used in this chapter and this symbol means that like in English she should say the word, this is that.”

(Interviewer: How you say it and? ---)

“Ya and like what does this mean, and that. Write the symbol and that some. Like they should totally explain the symbol that they use in calculus you know the symbol.” (5-7)

“Um, --- I don’t know. It’s quite difficult to know. The thing I can listen to some vocabulary --- and tell them before the lesson and try to look it up from the dictionary and they should know before the lesson.” (7-8)

“Ya like I think the teacher should also explain that because you know I was giving you the ‘sum’ example right like I know um the Canadian born people like they will not be need explanations for these kinds of words right but I think like the students whose English is not first language, the teacher should you know first of all like tell the difference like for the general language word and the math word you know, like so the student
should not get confused like what are they saying in the question, like they should first tell you know the students. That’s what I think.” (5-7)

“Well, since you used [tangent] in different chapters, the definition would apply slightly different to each chapter you’re teaching, so I don’t know, I think you just have to enforce it in each chapter by itself.” (16-12)

ii. Rate of speech: Students indicated that they would be able to understand better if, when explaining concepts and doing examples, teachers would try to speak more slowly.

“I think uh its uh easier if --- if teacher talked a bit slower and uh the listening would be better for the students.” (1-1)

“Uh ya of course because like also uh like speak slowly” (11-6)

“Well, maybe teacher can talk more, a little slower.” (10-5)

“... So in here, like they should I think they should, teachers should be like very slow for students whose English is not first language. They should like go really slow and explain each and every thing, like not really um, how should I explain it, like you know not go very fast ---“ (5-7)

iii. Vocabulary and presentation: Some students suggested that teachers should use short sentences with words that are meaningful to the students - “easy” or “everyday” words. Simple repetition is also useful for some students whereas others prefer different explanations of the same concept.

“I think we (they) have to use the language we speaking.” (11-6)

“Maybe use easy word.”
(Interviewer - Use easy words. Okay. And what makes a word easier?)
“Common words like we using conversation.” (10-5)

“Ya, I think more detail, way of asking and instead of having solely the words like a bit easier vocabulary. That’s what I think.” (17-11)

“The teacher use like simple words uh or like own word like you usually use in normal language so that helps me, cuz the questions sometimes
complicated and you don’t know what they’re trying to say but like when the teacher use like his language like for explanation it helps... yup, talking language.” (4-3)

“Street talk, that’s good. ... First of all when I come to class I said, ‘Oh it’s just math.’ ... and when they come to class it’s like if something normal.” (17-11)

“He should try to use like more easy words like this different words like this one and this one.” (4-3)

“Like when uh you can use simpler vocabulary” (2-9)

“Ya ya ya okay when the teacher writes they can write long word but they way they speak it must be easier, not too complicated. ... Ya because when the student learning, when the student in the class they listen to their teacher, what teacher say, right. On the board they just copy stuff they don’t think about it, they just copy it in their book and then they go home and they go over their notes right. So I think in the when the teacher writes they can write some long words but the way they speak they must speak like simple simple.” (3-2)

“Maybe you can use the difficult words first, then you can you know say like in other words it’s uh it’s saying like --- you put in the smaller words and it will help me to get the idea.” (10-5)

“Um (laugh) --- I um, when I’m listening to a lot of example, when the teacher explain almost the same thing over right, I can tell what they are talking about ... . (10-5)

“Ya, cuz I can get used to it like if he used the same thing again then I will get more easily what he’s trying to say.” (4-3)

“Like if you like um if you can more understanding in that questions because if first time maybe I don’t listen very carefully umm then second time that would be better.” (11-6)

“Well, the teacher can do it can explain the concepts in different ways. Like I think that’s the best way you can do it.” (16-12)

iv. Individual help and student participation: Students indicated that they often profited by an individual explanation or one on one work with the teacher.
Also, they would tend to pay attention more if they knew they would be questioned in class.

"Uh maybe you can have an extra help for those students who is ah using English as a second language ... ." (10-5)

"It's just not happened like one time it happens many times, if I don't understand, a teacher helps me I will understand." (4-3)

"I think teachers like teachers know that like one person was in her on her class was ESL you should pay more attention to them and try to help them individually like don't try to be, don't think like they know everything but, just try to help them." (4-3)

"When I ask ask the teacher, teacher come beside me and if I don't understand that he could write a both example anything about that." (15-10)

"... like pick one by one like not you know pick one by one so that the understand, right? Because in India right the teacher used to do that and that makes me attentive in class like because I know she's going to ask me afterwards whatever she's going to teach me, right? ... So you should do that because from that I will know, ya she is going to ask me so I should better listen ... ." (5-7)

"Like you can do it, you can one on one and explain it on with symbols, with words and then pictures, visually, that's maybe one on one, ya." (Interviewer: Okay, more one on one work in the class. Why would more one on one work be better?)

"Because you would force that student to absorb whatever you want to teach them, because when they don't understand what you're saying they go off to think other stuff." (16-12)

b. Visual aids: This last quote has indicated another suggestion to teachers that was reiterated by other students. Visual aids such as diagrams and graphs as well as written explanations, NESB students indicated, are a benefit to them in the English speaking mathematics class. Students indicated that the teacher should write explanations on the board while, at the same time, explaining the
concept verbally, should give example problems and should use graphs and diagrams where possible.

i. Board work: Although students indicated that they often understood the verbal explanations better than the textbook explanation, which they considered too formal, they indicated that it was important that the teacher write explanations to accompany the examples they present on the board and that they do a lot of examples. The students could copy the work and later, if necessary, translate it to get a better understanding of what the teacher had done. Terms could later be looked up in the dictionary or they could be discussed with other students who spoke the same first language.

"The teacher, I think uh the teacher should write uh something on the board like much and then if if we don't understand what what he talking we can see it at the blackboard and if we don't know either and we can read the notes and we if then after class we can ask the speak the same languages classmates." (15-10)

"Ah if they write down the complete sentence that would be better than just a few words on the board because after the class they can look in the dictionary if there's something they don't understand. Be able to put down a few notes it might help." (7-8)

"Ah in calculus writing and talking. Its a bit complicated any your explanation really help like talking and writing." (17-11)

"I think the teacher should do more examples on the board." (15-10)

"More examples on the board, more detail, like one or two detailed explanations and then more examples.” (16-12)

"So maybe I just need extra help or explain the word and pattern of the problem.” (10-5)

"Ummm I would think teacher can give me some examples. Like you know the situations that will work like this."(10-5)
"I think you have to give them more word problems and the more you practice the better you get at that." (16-12)

ii. Diagrams: A diagram used to model a question is useful in many situations, second language learners indicated. Diagrams help to visualize the situation and make it much easier to remember the process and the meaning as the figure or picture will remain in the student’s mind more clearly than words that have little or no meaning to him/her.

"Um, --- I think not theory. Theory will never help the students because that’s what my experience is, right. I think the pictures and like you know visualizing them and like you know videos right like something teacher in a video and pictures like that will help more to the students because theory like we will read it and like we will just read it leisurely right and we will read it and we will say ‘Ya we understand.’ But if they are looking at the pictures right we are keeping looking at that same picture, what is it saying right, and that’s going to go into their mind, ya that was the picture was going like this and like that and that right, but the words you know you never remember the words cuz it’s all the same, like make this and that right, so I think the picture and that makes more difference.” (5-7)

"What kind of English drew pictures and things you can show me like how the word works in mathematics.” (10-5)

“Well I think uh maybe just some graphing.” (18-13)

“Ya, well in geometry last term you showed me a diagram. You explained the sentence in a diagram and that I understood.” (17-11)

“... or did examples like when we do it that’s the thing. If this happens I guess with diagrams and stuff like that when sometimes we do it visual physical model.” (6-4)

“Yes. Pictures help a lot.” (10-5)

“Cuz the way she explained it, it was totally related to the diagram that we see from the compression and --- .” (2-9)

“So they should draw a picture that’s what we are looking for, right?” (5-7)
“You just have to give them examples, ya, usually visual examples, like graphing and something like that.” (16-12)

“... but in trigonometry drawing and explaining did more help.” (17-11)

“Draw pictures, visual, more visual and more talking, explaining in easier words easier words.” (17-11)

c. Organization: An initial overview of a unit was thought to be useful by second language students in the mathematics classroom, followed by a very organized, step by step presentation of concepts. Written explanations of the process, as mentioned previously, should accompany these.

“Okay, first like the teacher, like the topic we are doing, right, calculus, you should explain what the word calculus mean ... should tell what’s the use of it.” (5-7)

“Ya, because its math because you have to explain thing like step by step so you can’t explain everything at once right, you have to go step by step so.” (4-3)

“Like show all steps and then maybe put words or ideas beside key points key components.” (16-12)

“Go through it step by step ya. For me I have to go through like logically, I can’t, like okay this is the thing and then you think about it but I have to do it step by step like the teacher teaches step by step instead of like jumping around.” (3-2)

“Um well for longer questions that are really complicated, the teacher should like do it on the board, then write just the steps, like how he does it, first he does this then he does that like number them.” (2-9)

Summary

This chapter has discussed problem areas identified by senior mathematics students whose first language is not English, but where English is the language of instruction. In
addition, it has focused on those strategies that they use to help themselves better understand the concepts presented and on teacher interventions that they thought would help them better understand the instruction in the mathematics classroom. Problem themes developed around their understanding of the English language which included basic comprehension of the language, the mathematics register and the expressions that have particular meanings in a mathematical context. The differences between the usage of a term in daily conversation and the same term used in a mathematical context created problems for some NESB students and they felt that these problems would be alleviated if the differences were delineated at the onset. Similarly, any terminology new to a unit, they indicated, should be presented before being used, possibly in a vocabulary list at the beginning of each unit.

Problems that were more difficult to deal with were those associated with the structure of the English language - the semantics and the syntax. Students suggested various ways to deal with these, many of which relied on translations into their first language. Most students found it helpful to work with other students who have the same first language but who have a better understanding of the English language. They could then discuss the topics in their first language, having the advantage that the student with the better command of the English language would be better able to understand the teacher's explanation and could interpret it to the students whose understanding of English was not as good.

Another concern to the students was their lack of confidence regarding their own usage of the English language and the fact that the teacher could not understand the questions they are trying to ask well enough to help them with their mathematical
problems. Teachers, they indicated, will often misinterpret the question being asked and will give an answer that is not related to the student’s problem.

In Chapter Five, these findings will be discussed further and will be related to the literature review. Interconnections among problems and solutions will also be discussed, as well as the complexity of some of the student’s statements and their insights into their problems and solutions. Limitations of the study and implications for further research and teacher practice in a mathematics classroom with a multilingual student population but a unilingual teacher will also be discussed.
CHAPTER FIVE
DISCUSSION

Introduction

In this study, eighteen senior mathematics students were interviewed with the view to determine those linguistic factors that they felt helped or hindered them in their attempt to learn mathematics in English when English was not their first language. Students selected were to have completed at least their elementary schooling in a non-English speaking environment. Interviews of two students who were originally chosen because they represented two different languages were not used in the analysis when I realized that part of their elementary schooling had been completed in an English speaking school in Canada. The interview with a third student who had been attending an English school for eight years was retained, however, because he regularly spoke his first language with other students and he was used by several other students as an interpreter. I thought that his statements would give some insight into the thoughts of those students for whom he interpreted. The remaining fifteen students had been attending a school in which English was the language of instruction for four years or less and not all had initially been integrated into a mainstream mathematics class. It should be noted that a few students stated that during their high school years in their home country, the mathematics textbook that was used in class was written in English, but that the language of the instruction was their first language. They indicated that they did not read the textbook, but only did the algebraic questions.
While they had various levels of mastery of the English language, all the students interviewed seemed anxious to express the frustrations they felt in their attempt to cope with learning mathematics in English as a second language. They were willing to share their coping strategies and the strategies or methods that they thought could or should be used by teachers to help them better understand the mathematical concepts presented. As Ginsburg (1981) stated, “if you want to know what someone is thinking, ask him” (p. 7). Even though initially, several of the students indicated that they wanted to participate, but that they did not want to spend very much time in the interviews, they often stayed much longer than they had initially indicated they wanted to. That is, once they realized they were being listen to and that their ideas were considered important, they were very willing to spend time trying to clarify their ideas.

Some students arrived at the interviews with very definite ideas of what they wanted to say while others needed to be prodded. At times, consistent with the Clinical Interview (Ginsburg, 1997) the questions were directed to determine if specific problems existed or to determine if student responses were being correctly interpreted. All students interviewed were able to identify aspects of the English language as used in the mathematics classroom that made it difficult for them to understand the concepts presented as well as to identify ways that they dealt with those problems and interventions on the part of the teacher that they thought would or did make the learning environment more beneficial to them as second language learners of mathematics.

The study did not focus on the actual discourse of the classroom, but rather, on the types of teacher-student, student-teacher and student-student interchanges, activities and
explanations that the NESB students stated as being helpful/hindering to their understanding of the mathematics being presented in English.

After analysis using The Constant Comparative Method (Glaser & Strauss, 1967), the helps and hindrances identified in the interviews were grouped and classified under various headings. It was noted that many of the situations that the students identified as hindrances were similar to problems that had been identified in previous studies (Moschovich, 1996; Garaway, 1994; Gibbs & Orton, 1994; Garbe, 1988, Jones, 1982, etc.). Headings used, therefore, although not predetermined, reflect these similarities.

The fundamental differences between the setting of this study and that of previous studies are with respect to the age of the NESB students involved and the multilingual aspect of the classroom. The approach was also different in that the students were asked to identify situations that they themselves found helpful or hindering in learning mathematics in English as a second language, rather than being presented with situations that were thought to be either helpful or hindering and to confirm or deny them. The results reflect these differences in that the students were willing to discuss their problems and were able to identify for themselves, if not solutions, at least interventions that do help or might help them in their understanding. A possible reason for this process working well is the maturity level of the students. They ranged in age from 17 to 21 and seemed to be able to think through what they are doing, and are able to articulate their ideas more clearly than are younger students. Of possible significance, also, is the fact that while most of the students in this study would fit into Cummins' (1979) dominant bilingualism category, they are in neither an immersion nor a submersion program in that they are generally allowed to use their first language and it is often reinforced in their home and community
and even through some media presentations. There is also, generally, an attempt on the part of teachers to try to understand some of the cultural differences and expectations.

The interview process

The Clinical Interview (Ginsburg, 1997) proved to be a suitable method for extracting the information sought in this study. Since English was not the first language of the students, but was the language in which the interviews were conducted, clarification and reinterpretation of statements was often necessary. Students’ pronunciation and grammar was often incorrect and confusing and I would have to restate what I understood to be the meaning in order to clarify that meaning for myself, or sometimes I would extract the meaning from context. Such was the statement “they are boring you”, part of a quote used earlier from student 5-7, which actually meant, “you are boring them” or “it will better understand the vocabulary”, student 10-2, which, in context, was interpreted as “I know the work in my language and can better understand what the teacher is saying”.

Also, as the students indicated in their coping strategies that their understanding of the spoken word is better than their understanding of the written word and better yet than their ability to state their ideas in English, I feel that restatement led to better interpretations of what the students meant than if their statements had been taken at face value. For example, on several occasions, restatement clarified the difference between a positive and a negative statement as the “not” would be missed or not heard in the student’s original statement.

As Ginsburg (1997) suggested I would sometimes purposely misinterpret what I understood to be the student’s meaning, “to see if she would grasp at any straw” (p. 92). On other occasions, I made honest misinterpretations. There seemed to be a “relationship
of trust and mutual respect” (Ginsburg, 1997; p. 113) between the students and myself as they did not seem to be intimidated and firmly disagreed with me on several occasions, for example, “No, that’s too strong”, student 1-1, when they thought that I had misrepresented what they had stated. As this happened both when I intentionally misrepresented and when I did not realize that I had made a mistake, I feel that a reliable interpretation of the students’ comments resulted. Lastly, since the students stated that they felt uncomfortable talking in front of their peers for fear of being ridiculed for their lack of knowledge of English, I feel that the one-on-one interviews provided the students with a forum where they were honest and open. These aspects of the interviews and analysis lead to a trustworthiness of the results.

With respect to Flanagan’s (1954) Critical Incident Technique, only one student was able to identify a specific occurrence within the English speaking mathematics classroom where the teacher’s use of language confused him. Most gave general situations and indicated that often they did not understand what the teacher was saying and had to rely on translations into their first language or interpretations and explanations by other students. A number of students also indicated that individual explanations or help from the teacher aided them with their understanding of the concepts presented. The fact that this idea was stated, not by one student, but by a number of students and that the students indicated that it had helped them on a number of occasions, indicates that they were important factors and as such, I feel they should be considered significant incidents with respect to this study.

Students were able, however, to give specific examples of vocabulary that confused them when it was presented in a mathematical context and they had experienced
the same terminology in a non-mathematical situation or if they experienced the word in
two different mathematical contexts. Examples included words such as differentiation,
sum, pi (pie) and tangent. With respect to the word “differentiation”, it may be worth
considering the fact that the students would refer to the “high” vocabulary of the teacher
and at the same time knew a word as complex as this one and its use in everyday
language. It is also interesting or worth consideration, that a mathematics teacher, on
hearing the word “differentiation” would most likely think about the mathematical process
of differentiation, whereas, it is unlikely that an ESL teacher or an English teacher, in
defining the word “differentiation” for a second language learner, would be aware of the
fact that there was such a process or if he/she were aware of it, that he/she would consider
that meaning when defining the term in class. The confusion that could result over the
word “pi” was self evident in the transcription given previously where the student (5-7)
did not seem to realize the difference between the spelling of the words and thought of the
Greek letter, pi, only as the symbol, but if it were verbalized, it was “pie”, a dessert. The
word “sum” was also of significance to me, in that I was not able to understand the
problem that the student was having with it until I listened to the tape with my advisor and
heard her explanation. Then, after hearing other students of the same cultural background
as the first student use it in the same manner as she had, the confusion became clear. The
interpretation that they were using was one, that as a North American adult, I had never
heard. The term “sum” to me had always meant and been used to indicate the answer to an
addition question. However, to these students, it meant “Find the answers to the following
questions [regardless of the operation involved]”. It is interesting to note, also, that all
three of these examples of confusing words were best articulated by the same student.
This may imply that although problems are general, some are more specific to certain students. One may wonder, if this student, who was so able to express her confusion over specific terminology, or register, very clearly had as many problems with syntax or semantics, two other problem areas identified, but neither of which she articulated as specific problems for her. The idea of student specific problems, therefore, is in need of further investigation.

The Constant Comparative Method (Glaser & Strauss, 1967) for analyzing the data proved to be a suitable method for classifying student's responses. Some incidents were better classified taken in context rather than as isolated statements (Woolsey, 1986) and this would not be obvious on first reading. The Constant Comparative Method allowed for coding and analyzing data, as well as for redesigning and reinterpreting statements as new information became available. This was a necessary aspect of the analysis of the data of this study as I had to rethink and reclassify what a statement made in one interview really might mean when considered compared to statements on similar ideas in another interview, as, for example, the previously mentioned example of “sum”.

**Bringing together problems and coping techniques/advice to teachers**

While many of the hindrances to learning mathematics in English as a second language identified by senior NESB students are similar to those identified in previous studies with younger students, the primary difference between those studies and this was that the secondary students were able to identify and articulate them as problems and were able to specify methods that they used to cope with them. Asking students what they felt helped them in understanding the second language presentations of mathematical concepts appears to be a fairly new concept, or, at least, one that has not been widely used in this
area. It provides for a fresh, insightful view into some of the problems and possible solutions to learning mathematics in a second language from the viewpoint of senior students.

A focus of this study was to determine what teacher interventions helped/hindered students' learning of mathematics in the English speaking mathematics classroom from the perspective of senior second language learners. The hindrances or problems identified as language based were not all "caused" by the teacher, but students indicated that they thought that some of the problems could be alleviated by specific teacher interventions or methods of presentation. It is important, therefore, I think, to consider the student coping strategies and what teacher strategies they felt would help them overcome the different hindering aspects. Their ability to identify and verbalize helps and hindrances is important and the results of their efforts will now be discussed.

While students felt that it was their personal responsibility to learn enough of the English language to cope in the English speaking mathematics classroom, they felt that they could cope better if the teacher spoke more slowly and used more visual representations in the presentations of new concepts. Some students indicated that they thought that the mathematics teacher could not help them with their English, or maybe that they did not think that it was his/her responsibility to do so, as student 15-10, who said "We, the the teacher, the math teacher cannot help, help us too very much. You know, he, he just the math teacher no the English teacher". This may imply that the students do not realize the significance of their understanding of the structure of the English language on their ability to understand mathematics.
Some of the students stated that generally they understood the spoken language better than the written language and that the language of the textbook was often too formal and theoretical for them to understand. A suggested teacher technique, then, was to give rich verbal descriptions of the examples and theory presented but at the same time to be sure to use simple, everyday words with which the student could associate. This did not preclude the teacher giving written explanations because the notes would be useful for later reference. The verbal descriptions, some students thought, should be in “little” words or “ordinary” language, possibly related to student experiences. Written work, they indicated, could be more formal than the spoken word and could use more technical terms. While this may sound contradictory, students explained that they would be able to relate the written work to the teacher’s verbal explanations and that they could look up unknown terms in dictionaries or ask friends for translations into their first language if necessary.

Not all students, however, thought that the mathematical terms should be related to things in everyday life. Some felt that this would only create confusion as to the exact meaning of the term in mathematics. Thus, for some, everyday references were a help, whereas for others, they were a hindrance. This is in agreement with Frid’s (1993) findings that relating a mathematical term to an everyday experience would be a help or a hindrance depending upon how the student was able to integrate the everyday usage with the technical usage. The fact that some students did not like to relate mathematical usage to everyday usage also agrees with Moschovich’s (1996) and Johnson’s (1996) references to cross register confusion. This also gives support to the previously mentioned idea that each problem and/or solution may be specific for each individual second language learner.
One concern that should be mentioned, from a mathematical point of view, is that if students want to relate mathematical terminology to everyday experience, they may possibly not realize the importance of the mathematics register and the need for exactness of meaning. While relating to the everyday meaning of a word, the student may be missing the precision that is needed for a proper mathematical understanding. On the other hand, there are situations in which the relationship between the term as used in mathematics and the term as used in “everyday life” is very subtle and would require an in depth understanding of the English language and mathematics to see that relationship. Such is the word “differentiation”.

One specific problem mentioned by students with respect to knowledge of the English language and its use in the mathematics classroom was with regard to the use of slang in that these statements are not directly translatable, or if they are, the result is a meaningless statement. As mentioned by Cuevas (1984) and Santon (1994), many statements may be understandable to a native speaker of the English language, but this may not be the case for second language speakers. Their statements refer to the grammatical nuances of the language, but it would seem that slang expressions could fall into the same category. This topic, unfortunately, was not pursued during my interviews but warrants further consideration.

Students indicated that they often experienced problems with the mathematics register. If the topic had previously been studied in the student’s first language, he/she would tend to translate the terms to his/her first language and “think” it in that manner. As with the above situation where some students wanted to relate terms to everyday experiences and others did not, a few also indicated that they did not want to use their first
language vocabulary as this created cross language confusion. Moshkovich (1996) observed cross language confusion with register with Spanish speaking students in the mathematics classroom. Again, individuality must be considered.

If a topic had not been studied in the student's first language, as for example, the topic of calculus, the students in this study indicated that they could not make a conceptual connection with the term. There seemed to be nothing for them to relate it to, and to alleviate this problem, students suggested that the teacher could prepare a vocabulary list at the beginning of each unit, along with definitions and appropriate mathematical notation, so they could formulate some idea of what would be studied before beginning the unit. This finding is in agreement with results of various other studies which indicate that direct teaching of mathematical register may actually improve mathematical performance (Dawe, 1983; Garbe, 1985). These studies, however, do not directly address the concept of notation which seemed important to some of the students in this study.

Vocabulary lists would also help with the problem of words that are pronounced the same but have different spellings or have different meanings in context. NESB students in this study indicated that they had a difficult time extracting the correct meaning when they were presented in different contexts. Dirkin and Shire (1991) refer to this as lexical ambiguity. Students felt that by having the terms and symbols available before they had to be used in context it would better prepare them for understanding and using the terms in a correct context.

When two or more mathematical concepts combine to form a new concept it is not sufficient to simply learn the definitions of words, but the expressions and the context in which they occur must be considered (Dale & Cuevas, 1987). Students in this study
similarly indicated that even though they could often understand each word in a question, they could not understand the question. The coping technique, although not specifically identified as such, seemed to be to reread the question until it started to fit into a pattern that made sense to them. It seems that the students look at individual words and possibly do not realize that some of them go together to form an expression with a specific meaning. This discussion leads directly to the problems identified as syntactic or semantic and to the solutions to them as identified by the students.

The syntax and semantics of the English language were identified as problems by second language learners although they did not label them as such. Students indicated that they had to reread questions many times to try to understand them, and that often they just tried to fit the question into a pattern that followed other questions containing some of the same words or that they would use an axiom which they knew applied to that particular topic or unit in the course. These methods of coping agree with those found by Stone (1988) where younger children looked for external cues such as the page in text, or for function words which would indicate a possible method of approach or the operation to be used.

The fact that different statements can imply the same thing in the English language was also indicated as creating problems for NESB students. This agrees with statements by Sinclair and Coulthard (1975) who noted similar problems for other NESB students. Students were not readily able to identify coping techniques or interventions on the part of the teacher that they felt were likely to help them with this problem. They indicated that they felt that it was part of the English language that they had to learn. Some suggested that a list of expressions with similar meanings might help or that having students who
knew English better and could explain the question in their first language was useful. They indicated this by stating that it was beneficial to be sitting with other students with whom they shared the same first language. On a cautionary note, however, there were students who disagreed with the concept of sitting with others who spoke the same first language as they thought that they listened and learned better in English if they were not exposed to so many first language speakers. It was not clear, however, if these later students were considering it a benefit to their English or to their mathematical understanding. I did not pursue this in this study, and it is a topic that deserves attention.

Students indicated a resistance to speaking out in class, both because of fear of being ridiculed and because they might not be understood. However, they did not indicate many techniques that they thought would encourage them to speak out more. Two did suggest that if the teacher directed questions to them specifically on a regular basis, they would have to listen more carefully and would be forced to overcome their reticence to speak out.

A final concern expressed by NESB students regarding their lack of proficiency with the English language in the mathematics classroom, which possibly relates to their self-consciousness or may be a cultural attitude or perspective, was that, if the teacher had to spend time explaining the various terms and expressions to them, this would be holding back the native English speakers for whom these would be more natural and require less explanation. This, therefore, discouraged them from asking for explanations and, once again, limited their personal use of the English language in the classroom. Often, in my experience, English speaking parents and students have expressed concern that second language learners may hold back the class because of the time required for explanations,
but I had not expected this same concern to be expressed by the second language learners themselves. This topic deserves more consideration.

Limitations

The purpose of this study was to identify linguistic situations that senior NESB students who had received at least their primary education in their first language considered as helpful or hindering in their attempt to learn mathematics in English as a second language in a classroom with a multilingual student composition. Although no further helps or hindrances were identified after twelve interviews were analyzed, some consideration must be given to factors relating to the format of the study and to the students involved in it that limit the generalizability of the results. Included in these limitations is, although the study wished to determine the helps and hindrances experienced by senior NESB students in the English speaking mathematics classroom, the students who volunteered to be a part of the study were a select group both academically and culturally.

All students involved in this study, although they had been studying mathematics in English for four or fewer years, were obtaining good grades in mathematics 12 or were considering retaking the course because they were not satisfied with their results. Needed to be considered, then, is if the helps and hindrances experienced by them are the same as those experienced by NESB students who are not achieving as well in the senior mathematics classroom or who do not have the same motivation to do better. A further consideration is that, although there was an attempt to obtain a multicultural overview, all students interviewed were of an East Indian or Asian background. Further research should involve students of the same age group who have different cultural backgrounds.
Most of the students in this study have experienced, in at least one of the last two years, a mathematics class in which they were seated at round tables of three or four and in which they were encouraged to discuss their work with other students. The problems experienced and the coping strategies used by them may be quite different from those experienced by students seated independently. Research in this area could also involve the "isolated" student, that student who has no classmates with whom he/she shares the same first language.

Another limitation to the study is related to the ability of the students interviewed to express themselves in English. Restatement and clarification of meaning, as discussed in the methodology section of this chapter, increased the trustworthiness of interpretations. However, different results could possibly be obtained if the interviews had been conducted in the student's first language or in English with a bilingual interviewer. Pattanayak (1986) suggests that first language instruction may place students at an advantage, and extrapolating from this, first language interviewing may provide for greater reliability in the interpretation of students statements in that the student could possibly express his/her ideas better because of his/her knowledge of the language.

Lastly, while some trustworthiness can be derived from the fact that I listened to and discussed one tape with my advisor, this trustworthiness may have been enhanced if I had elicited the aid of other individuals in determining the fit of the incidents to the categories as extracted.

Implications for the multicultural mathematics classroom

Two issues bear consideration when discussing senior NESB students in the mathematics classroom where English is the language of presentation but not the first
language of the student, and these should be considered in future educational endeavors and research. They are: 1. Most mathematics teachers have little or no training in teaching English, let alone ESL training, and 2. Mathematics is often one of the first classes into which NESB students are integrated.

1. With the emphasis that is being placed on explanations, problem solving and verbalization in the mathematics classroom in North America, it is my opinion that the mathematics teacher and his/her students are likely to benefit if he/she is more aware of the methods of presentation and speaking that help NESB students better understand the concepts presented in an English speaking mathematics classroom, as well being aware of the particular problems these students face and the methods they use to cope in this situation. Based on the analysis of the data from this study, some ideas and recommendations that I believe would be of benefit for senior NESB in the mathematics classroom where English is the language of presentation are listed below.

a. By identifying particular terminology that creates a problem for senior NESB students in the English speaking mathematics classroom, it may be possible to work with ESL teachers to develop a vocabulary list so the mathematical meaning of the terms can be integrated with the everyday meaning the students learn in ESL classes. This would make the transition of the usage of these terms in the mathematical context less taxing for ESL students.

b. At the beginning of a new unit, providing a list of essential mathematical terms and expressions prior to their usage in the classroom would help prepare students for the mathematical interpretation of the vocabulary. The difference between a
word used in a mathematical context and its use in everyday conversation should be delineated. Also, groups of words that form meaningful mathematical concepts should be indicated as such and their meanings explained.

c. Sinclair and Coulthard (1975) discuss verbal statements that take different forms but mean the same thing and the problems that these create for NESB student. Lists of families of such expressions that occur in the mathematical setting could be written up for students and these could be added to when new expressions were presented in class or in questions.

d. While technical terms should be used in the mathematics classroom, and proper usage of terminology should be expected, explanations should be given in simpler terms that students understand. In this way, the students would, hopefully, get a better understanding of the mathematical expressions as well as learn their proper use in context.

e. I have noted that students see their problems mainly in terms of “vocabulary”, but in fact their problems are not limited to vocabulary issues. The aim of this section of recommendations is to help students develop a broader understanding of their language difficulties in mathematics and escape from the limitations of the assumptions that “the problem is simply vocabulary”. It is therefore important to work with them to help them improve their ability to detect and express the problems they have. They could then possibly better explain their difficulties to the teacher and to themselves. To do this would involve:

i. showing them some of their difficulties with “little words”, connectives and prepositions, and helping them see that these are problematic to them.
ii. discussing the use of diagrams, visuals and objects as ways of explaining meaning which go beyond the simple definitions of words.

iii. drawing their attention to ways in which they try to grasp the meaning of larger stretches of discourse (as in word problems) which hopefully will counterbalance their tendency to concentrate on isolated words.

iv. drawing their attention to cases in which they do not find it helpful to translate a new word to their first language as this may help them realize that a word for word definition or translation is not necessarily helpful.

f. A variety of presentation methods should be used, and repetition, both direct and using other words, seems helpful to NESB students. Students benefit from alternate form presentations providing they realize that they are referring to the same concept. Also, visual presentations are particularly useful as students will retain the visual cue better than words that they do not fully understand.

g. Seating students in groups and actively encouraging them to discuss their mathematics seems to be a beneficial experience for NESB students. Some students prefer discussing their mathematics with others who share the same first language while others prefer to be with native English speakers.

2. That mathematics is one of the first classes into which NESB students are integrated seems to be a fairly widespread phenomenon (Garrison, 1997). Students in this study accepted it, as, from experience, do most teachers. The fact is, that many people still think of mathematics as non-language based and/or a universal language (Dawe, 1983; Lass, 1988). However, since the vocabulary of mathematics is very concise and exact
(Cuevas, 1984; Pimm, 1987), it may be one of the more difficult subjects into which to be integrated, particularly as the emphasis on problem solving and verbalization increases. While it is true that algebraic manipulation can be basically language free, understanding of concepts requires ability to conceptualize and extrapolate meaning in order to understand the situation (van Hiele, 1986). As several of the students interviewed in this study indicated, they were already acquainted with the material being presented in the mathematics class because they had studied it in their home country. This helped them in their ability to understand the concept when it is presented in English and helped build their confidence that they could succeed in the English speaking mathematics classroom. A possible implication, although it may be retarding their mathematical course work by one year, would be to place NESB students in a mathematics class that is one year behind their grade or ability level.

In order to help NESB students with the process of learning mathematics in English when they have a limited command of English and yet mathematics requires understanding of many subtleties of the language, I believe, based on the interviews in this study, that mathematics teachers must become more aware of the language based problems their students face and methods that the students use to cope as well as being aware of the teacher interventions that students think would be or are beneficial. In this way, I think, it may be possible that the students can better understand their mathematics as well as fine tune their English language skills.

Implications for future research

Much research has been done on the problems experienced by NESB students under the age of sixteen, and some at the tertiary level of schooling. Little, it appears, has
been done with recent immigrants at the senior secondary level. Some suggestions regarding possible areas for further research have already been indicated, but there are other situations that deserve consideration.

While this study has identified some areas of problems experienced by a limited number of senior NESB mathematics students from a limited number of backgrounds, it has left many gaps, and although no attempt was made to generalize the results in a statistical sense, some attempt has been made to coordinate the student's ideas to develop possible themes for further research. Some suggestions are listed below.

1. It seems reasonable to suggest that further research should involve students of different linguistic backgrounds. The linguistic backgrounds of the students in this study differed greatly from the English and all used an alphabet system that differed greatly from the one used in English. It is possible that different problems are associated with learning mathematics in a second language if the first language of the student is more closely related to the English language, both orally and symbolically (Dawe, 1983).

2. While some research has been done, again with younger students, where the teacher was bilingual and spoke the same language as the students, Moschkovich, 1997) and some where the teacher spoke the same language as some of the students, little seems to have been done in situations such as this study where the teachers involved were unilingual (English speaking) but the students spoke a number of different first languages. This area also deserves consideration.

3. Implied by the statements of some of the students in this study who had no other first
language classmates, they experienced different problems and solutions than did their classmates. This “isolated” student also warrants more research.

4. Generally, the multilingual, multiethnic situation has had very little consideration, and it is my belief that this condition will continue to expand and that more research is necessary.

Conclusion

We cannot assume that all the NESB students in a class understand what we say or that they have the same perception of the words we use. What we must realize is that they construct a meaning from their own experience and their understanding of the terms used that may or may not be in line with what we want them to understand. Their understanding will be based on their own experiences and on cultural and ethnic expectations. We cannot overlook the importance of the social nature of the meaning of a statement, both contextually and grammatically (Sinclair and Coulthard, 1975). Thus, the function of a statement made by the teacher in the classroom and the way it is understood by the student may in fact be quite different. It is important, therefore, for the teacher to carefully consider the terms used and the possible misinterpretation or contextual misunderstanding that may take place due to the fact that English is not the first language of the students, and also that the teacher realize that he/she may not be understanding what the student really means to ask. It is a situation that reminds one of the old saying “I know that you believe you understand what you think I said, but I’m not sure if you realize that what you heard is not what I meant” (Author Unknown). It is important that the teacher speaks and listens carefully and not jump to conclusions as to what is being asked or stated.
"Atawe began his first year of schooling at about the age of 8. He was taught by a Papua New Guinean who usually spoke Melanesian Pidgin, and sometimes English. Both languages were unknown to Atawe. A local teenage boy who spoke some ‘Pidgin’ translated for the teacher into Atawe’s own local language. The following year Atawe graduated to the next grade. This grade was taught by an American missionary who taught in English with a rare utterance of ‘Pidgin’. For many days Atawe sat in a fog wondering what was being said."

(Clarkson, 1991; p. 237)

"In a totally new learning process, an adult still relies on experience that a child has not had."

(van Hiele, 1986; p. 93)
REFERENCES


DEMOGRAPHICS QUESTIONNAIRE

TEACHER USE OF LANGUAGE WHICH HELPS OR HINDERS UNDERSTANDING OF MATHEMATICS BY SECOND LANGUAGE LEARNERS

1. Participant’s Number: ______________________ Pseudonym:_____________________

2. Sex (please circle) Male Female Age: ______________

3. In what country were you born? ______________________

4. At what age did you move from your country of birth? ______________

5. At what age did you move to Canada? ______________

6. In what other countries have you lived? (Please list and indicate the approximate length of time lived there.)

   e.g. Japan (2 years) ______________________ ______________________

   ______________________ ______________________

   ______________________ ______________________

   ______________________ ______________________

7. What is the first language you learned to speak? ______________________

8. What other languages do you speak? (Please list and indicate how well you think you can function in them.)

   ______________________ fluent moderate poor

   ______________________ fluent moderate poor

   ______________________ fluent moderate poor

   ______________________ fluent moderate poor

9. What is the usual language spoken in your home? ______________________
10. How many years have you attended a school in which English is the primary language of instruction? __________________

11. What, approximately, is your present grade in each of the following subjects? Please circle the appropriate letter or comment.

Mathematics  A  B  C+  C  C-  D  F
English       A  B  C+  C  C-  D  F  do not take
History      A  B  C+  C  C-  D  F  do not take
Biology      A  B  C+  C  C-  D  F  do not take
Chemistry    A  B  C+  C  C-  D  F  do not take
Physics      A  B  C+  C  C-  D  F  do not take

12. How well do you understand the English spoken in your mathematics classroom? (please circle)

Very well  Fairly well  Some  I only follow the symbols

13. In what language do you think when you do your mathematics? __________________

14. When working with other students on your mathematics, what language do you prefer to use? __________________

Why? __________________

15. Do you get help with your math outside of school? (Please circle)  Yes  No

If yes, is the person who helps you (Please circle)


If yes, in what language do you receive the extra help? __________________
APPENDIX E

GUIDING QUESTIONS

These questions will be used to help direct the students to some ideas if they do not have ideas they want to express already formulated. They will be varied depending on students’ responses. Other questions will be asked if a student shows interest in, or problems with a specific aspect of the language.

1. I would like you to think about the time you have spent learning mathematics in English. Can you think of any ways the teacher has explained things that has made it easier for you to understand the concepts. That is, is there any method or way of explaining or talking in the math classroom that makes it easier for you to understand?
2. There are certain words used in the math classroom that have a special meaning, special math words. Is there any way that the teacher can make it easier for you to understand the important math meaning of these words. Do you like a theoretical meaning, or do you prefer to relate them to everyday talking? Can you give me examples?
3. What is it about the way the teacher talks that makes it easier/harder to understand? Can you describe a situation in which the teacher explanation made it easier or harder for you to understand what he/she meant?
4. Do you prefer if the teacher talks a lot or do you prefer it if the teacher writes more?
5. Do you read your math textbook? Why? Why not?
6. What language do you use when you are doing your math? What language do you think in? Why do you think you use English/your first language?
7. Do you work on math with other students? When you work with friends, what language do you use? Why? How does this help? (If in first language) Does it then make it easier of harder to understand the teacher’s explanation in English? Why do you think it does (not) make it easier?
8. Do you use a dictionary? English/first language?
9. Do you think it is easier or harder for you as a second language learner to learn the math terms than it is for an English speaker?
10. English has a lot of “little” or “connecting” words. Do these ever bother you? (Words like if, of, at, etc.)