The Role of Language Switching in Iranian Bilingual Students When Solving Mathematical Problems

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DECLARATION

I certify that except where due acknowledgement has been made, the work is that of the author alone, and the work has not been submitted previously, in whole or in part, to qualify for any other academic award; the content of the thesis is the result of work which has been carried out since the official commencement date of the approved research program; and, any editorial work, paid or unpaid, carried out by a third party is acknowledged.

Zahra Parvanehnezhad Shirazian
20 November 2006
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ABSTRACT

The purpose of this study was to explore the role of language switching in a group of Iranian bilingual students while they were involved in mathematical problem solving. Language switching has been viewed as a common practice in bilingual students in their classroom, particularly for mathematics learning. In bilingual students, using their first language to solve at least part of a problem may facilitate mathematical thinking and lead to a successful problem solving process. The bilingual children in this study were comprised of sixteen Iranian non-English speaking background (NESB) Year 4 and 5 students who attended state schools on weekdays and participated in two Persian schools on weekends during term 4, 2005. To address the main aim of the study, four research questions were posed; (i) To what extent do Year 4/5 Iranian NESB students use language switching while solving different types of mathematical problems?, (ii) What factors prompt language switching (if any) in this sample of bilingual students?, (iii) Is there any relationship between proficiency in the L1 (Persian) and L2 (English) languages and mathematics performance/competency?, and (iv) What, if any, relationship exists between students’ background and language switching?

After completing a pilot study and reviewing the results, a qualitative case study methodology was chosen as the most appropriate means of providing in-depth data for the main aim of this research. Based on Clarkson’s (1996) study, data was derived from the transcripts of a semi-structured interview, two language comprehension tests, and a questionnaire administered to parents. The interview was comprised of two phases; a mathematical problem solving phase which involved three different types of mathematical questions (word problems, symbolic and open-ended questions) and an associated Language Switching Checklist; and, in phase 2, a series of questions about the student’s problem solving strategies, their use of language switching, and home background. Language comprehension tests comprised of an English reading comprehension (TORCH) test in a cloze format, and a Persian reading comprehension test in a short-answer format, were used to determine the level of students’ proficiency in English (L1) and Persian (L2). The parent questionnaire contained items regarding home status and background, such as parents’ expectation for their children’s education, and the language spoken most of the time at home.

Results showed that a large proportion of Iranian NESB students used language switching to solve the three types of mathematics problems, particularly word problems. In focusing on
the type of questions attempted, language switching occurred more frequently in solving word problems. The main reason for language switching in this group of bilingual children was problem difficulty. An in-depth investigation of the data showed that difficulty in comprehending the problem and/or implementing an appropriate strategy, prompted language switching. Other factors influencing language switching were: familiarity with particular numbers used habitually, and being in the Persian school or interview environment. Findings indicated that high proficiency in both languages may be associated with high competency in mathematics. Parents’ attitudes and speaking Persian at home may contribute to the event of language switching in Iranian NESB students when solving mathematical problems.

The number of students involved in this study was far too small to generalize the findings. However, consistent with the findings of Clarkson (1996) and Latu (2005), the phenomenon of language switching by bilingual students should be considered in mathematics classrooms. Improvement of both L1 and L2 proficiency appears to be associated with the level of mathematical performance, as presented in the literature (Clarkson, 1996; Clarkson & Dawe, 1996; Erktin & Akyel, 2005). Presenting mathematical questions in a simple or reworded format could assist bilingual students to comprehend and solve a problem properly. It is suggested that these findings should be taken into account in developing an appropriate mathematics curriculum for bilingual students in an Australian context.
CHAPTER 1 — INTRODUCTION

1.1 BACKGROUND
As an Iranian student studying in my country, I always enjoyed the mathematics and physics classes. I remember my teachers’ encouragement to pursue my studies in these fields when I was studying in secondary school. My tertiary education was in mathematics and physics. I started teaching 16 years ago in a secondary school as a physics and mathematics teacher. One of the main reasons I selected this career was my interest in mathematics from childhood, as well as my success in mathematics and physics, when I was a student at school.

Together with my family, I arrived in Australia in 2002 and spent one year studying English. It was quite challenging to speak and write in English while being in an ESL (English as a Second Language) context. Although I studied English from middle school in my country, Iran, in an EFL (English as a Foreign Language) context, I did not have much opportunity to make progress. As a bilingual student, as well as a newcomer to this country, I was very interested to know to what extent the Persian and English languages were used when a child is involved in doing mathematics. Firstly, as a parent when my children were attending childcare (kindergarten), I was impressed by the interplay of languages in my children. When I spoke to them in Persian (L1), they replied in a mix of L1 and the language of the community, English (L2). When my son went to school and started learning mathematics and working with numbers, it was exciting to observe how he switched between languages in some circumstances, for example, the expression of certain numbers such as one digit numbers. A visit to two Persian language schools in Melbourne provided an opportunity to further discuss this issue with the Persian language teachers. One of the teachers stated that most of their students switched between Persian and English, such as for particular numbers or words, while studying Persian in the classroom. This glimpse of language switching provided me with a new perspective on bilingualism and caused me to consider its role in bilingual children’s mathematics learning and in particular what prompted language switching when Iranian bilingual students solved mathematics problems. I reviewed the literature of mathematics performance for different bilingual groups. Although there were some studies on language switching in some ethnic groups, there was no study in this regard on Iranian bilingual students in Australia. This research, therefore, was designed to explore the extent to which language switching was used by a group of Iranian bilingual students when solving mathematical problems.
1.2 PROBLEM STATEMENT

Between one-half to two-thirds of the world’s population is bilingual or multilingual (Padilla, 1990; Baker, 2001). Multilingualism and multiculturalism, which are social facts of this new century, can be seen in every classroom and playground (Luke, Comber, & O’Brien, 1996). Being able to speak, read, and write in the English language, for bilingual students in an ESL context is considered important, because “English is the main language required for school success and interaction with wider society” (Molyneux, 2004, p. 6). The increase in English literacy is due not only to its being the main medium for scientific as well as academic purposes and its role as the main world trading language but also due to extensive use of English in social networks.

Australia is a relatively new country with considerable ethnic and cultural diversity. The fact that 40% of the total population are either first or second generation Australians is a unique characteristic of this diversity (Swetnam, 2003). Immediately after the Second World War, the number of immigrants to Australia increased, initially from European countries, and then gradually from, Africa and Asia (Bullivant, 1986). After the 1979 revolution in Iran a large stream of migration from Iran began. This pattern of migration was heightened in the 1980s during the period of war between Iraq and Iran. Newcomers from Iran settled in different parts of Australia with most settling in Sydney, Perth, and Melbourne. Nowadays, there are around 5,000 Iranian migrants living in Melbourne (Homayooni, 2004).

Up until the 1960s, being bilingual was assumed to be a disadvantage in schooling, for example it was believed that,

bilingual students who attempted to use both languages in the classroom would inevitably have to contend with the confusion between the languages that would certainly ensue (Clarkson & Dawe, 1994, p. 173).

This view was mainly due to ignoring the level of proficiency in either language as evidenced by Clarkson and Dawe’s (1994) claim that:

One explanation … was found in a more careful stipulation of what bilingualism was. The fundamental idea advanced was that viewing bilingualism as a global state, which you had or did not have, was too gross. Finer grading of levels of bilingualism were needed (p.173)
However, Lambert (1977) noticed that a high level of proficiency in bilingual students contributed to their educational performance. This new perspective was supported by the later studies conducted by Cummins (1979, 1991), Dawe (1983), Clarkson (1991, 1992), and Clarkson and Galbraith (1992) across different area of the school curriculum, particularly mathematics. Several studies on bilingual students have recognised the important interplay between languages (language switching) in solving different types of mathematical problem in some ethnic groups in an ESL context (Clarkson & Dawe, 1994, 1996; Clarkson, 1996). Bernardo also conducted some studies (Bernardo, 1999, 2002; Bernardo & Calleja, 2005) on NESB Filipino students in an EFL context, and focused on the relationship between word problem solving and the language used in the word problem.

A review of the relevant literature found that there were no studies on Iranian Non English Speaking Background (NESB) students in regard to their academic performance, and in particular, on their mathematics achievement in an ESL context such as in Australia. NESB students are identified as people who were born, or their parents were born in a non-English speaking country (Clarkson & Dawe, 1994, p. 173). On the advice of Clarkson and Dawe (1994) to treat each group of NESB students separately, I felt that there was a gap in what was known about Iranian bilingual students’ mathematics performance in an ESL context. Therefore, I decided to conduct this study on Iranian NESB students who attended local schools during the week and Persian language schools on Saturdays in Melbourne, Victoria.

In this study, language proficiency in Persian (Farsi) as the first or native language (L1) and English as the second language (L2) was investigated. Although, Persian and English are both derived from the Indo-European language family, they are quite dissimilar in regards to syntactic structure and orthography, for example in Persian, the verb is put at the end of a sentence (Ali a student is), while in English, the verb is used after the subject (Ali is a student). Also the sequence of adjective-noun in an English sentence (good student) is opposite to the sequence in a Persian sentence (student good). Persian is written and read from right to left, while in English it is from left to right. The Farsi alphabet is similar to Arabic, with four additional letters. There are 32 letters of the alphabet in Persian. Each letter has one of three shapes depending on whether it occurs at the beginning, middle, or end of a word. These letters of the alphabet are distinguished from each other by the presence or absence of a dot or stroke. Based on this considerable dissimilarity between the structures of Persian and English, it was of interest to explore the extent to which language (Persian or/and English), is
used by Iranian bilingual students when solving mathematical problems in the Australian context.

1.3 RESEARCH AIMS

There is a considerable literature on the interplay between languages (L1 and L2), while bilingual students are solving mathematical problems (see for example, Clarkson and Dawe, 1994, 1996). However, there is no study on Iranian NESB students that has aimed to explore language switching. In particular, this study aims to investigate the incidence of language switching (if any) in a group of Iranian bilingual students in an ESL context as they engage in solving different types of mathematics problems. As in previous literature on certain bilingual students (Clarkson & Dawe, 1994, 1996, Clarkson, 1996), which found different reasons for language switching in different types of mathematics question, the factors which influence language switching in Iranian students are of interest to me. The relevant findings may have important implications for teaching and learning mathematics. These authors also explored the relationship between language proficiency and mathematics performance, as well as the influence of parents’ views and students’ background on language switching. These variables were also of interest in this study. It is assumed that the findings of this study will provide some further insights into the role of language switching for this ethnic group.

Based on this assumption, a qualitative approach, in particular a case study design, was chosen to enable the investigator to use appropriate instruments to address the research questions.

1.4 OVERVIEW OF THE THESIS

This section will provide an overview of the thesis. In chapter 2, to provide a broad picture of the context of this study, based on a review of the literature, theories related to mathematics learning, problem solving, and more specifically about the role of language in mathematics learning will be summarised. Some background features of bilingualism in terms of its context, and definitions of language switching, will be reviewed to address the main aspects of the study. Mathematics performance of different ethnic bilingual students in Australia will be discussed to gain an insight into bilingualism. Bilingual performance across different types of mathematics problems will be reviewed to examine the role of the mathematical context in language switching. Factors affecting mathematical problem solving such as difficulties with problem comprehension and/or implementing the appropriate strategies will also be reviewed. Linguistic factors that affect mathematic competency, such as language proficiency in L1
or/and L2; the nature of first language; and clarity of language in stating word problems in
different educational contexts (EFL and ESL) will be discussed. Finally, a more detailed
statement of the research aim will be presented and justified.

On the basis of the literature reviewed, Chapter 3 describes the research methodology used in
this study. Firstly, a theoretical basis for choosing a qualitative, case-study approach will be
justified. Then the details and outcomes of a pilot study conducted on four students to trial the
instruments and develop interview skills will be reported on. Based on the review of the pilot
study and previous literature, a modified replication of Clarkson’s (1996) methodology was
considered to be appropriate for the main study, which will be presented. The instruments
used in the main study, a semi-structured interview, language comprehension tests, and
questionnaire for parents, will be described in detail. Finally, a description of initial and
comparative analyses will be detailed and justified.

Chapter 4 deals with the results of the main study. Based on the research questions and the
instruments used, the summative data in relation to demographic data, and the students’
results from language tests and mathematics questions will be summarized. In order to gather
data relating to the main objective for the study, the extent of language switching would be
investigated, together with issues such as when and why switching occurred. The reasons for
language switching, such as difficulty with problems comprehension /interpreting and
implementing algorithms, familiarity with particular numbers used habitually, and physical
environment will be summarised. Finally, the relationship between mathematical competency
and language proficiency, and the relationship between students’ background and language
switching will be evaluated.

Chapter 5 includes a review and discussion of the results in terms of Clarkson’s (1996) study
in particular, and the literature more generally. The results related to language switching and
mathematical problem solving will be discussed in terms of the four research questions. The
results of this study will be evaluated against the literature in order to discuss the factors
prompting language switching. The relationship between proficiency in either language and
mathematics performance, and the influence of parents’ views and students’ details on
language switching will also be explored.

In Chapter 6, basic conclusions, limitations and implications of the study will be discussed.
The major findings confirmed Clarkson’s (1996) results with bilingual students from other
ethnic groups in relation to the occurrence of language switching during mathematical problem solving. The major reason which prompted students to switch to L1 was the difficulty of a problem. Findings also provided evidence which may support Cummins’ (1979, 1991) theory in terms of the relationship between proficiency in L1 and L2 and mathematical competency. A possible influence of using Persian language in the home on the event of language switching in these bilingual students was suggested. However, this sample was too small to be extended to generalise about all Iranian bilingual students. The limitation of this study in terms of a requirement of a cohort study with large numbers of Iranian NESB students will be described. Important considerations for this group of bilingual students in improving language proficiency and mathematics performance, and the relationship between these two, will be discussed. Finally, an explanation for the implications of the findings of this study in terms of teaching and further research will be presented.
CHAPTER 2 – LITERATURE REVIEW

The focus of this study is to explore the use of language switching by bilingual students as they engage in mathematical problem solving. It will involve a detailed examination of Iranian Non-English Speaking Background (NESB) primary students and their use of the Persian (L1) and English (L2) languages as they solve three different types of mathematical problems.

2.1 INTRODUCTION

A range of literature could be drawn on in order to inform and situate this study. To provide a general background and help identify the research that is most pertinent to this study, four broad areas of research will be considered briefly. The first of these will look at some of the literature relating to the educational experiences of children of immigrants in Australian school settings, in particular, studies related to their mathematics performance. This will be followed by a general consideration of research related to the learning of mathematics (e.g., Nesher and Kilpatrick, 1990), mathematical problem solving (e.g., Schoenfeld, 1985, 1992), and, finally, research related to the role of language in mathematics learning (e.g., Laborde, Conroy, De Corte, Lee, Pimm, 1990; Ellerton and Clements, 1991; Clarkson, 1991; Mousley and Marks, 1991).

2.1.1 Children of immigrants in Australia

Bilingualism, which is defined here as the use of two or more languages, is practised by three different groups: immigrant groups in developed countries, students in developing countries, and indigenous groups in developed countries (Clarkson, 1991). These three contexts have similarities as well as differences with respect to the interaction of learning and bilingualism. However, in the present study the first group comprised NESB children who were placed in an ESL learning environment.

Australia has a multicultural education system. Bilingual students and their parents are integrated facets of this multicultural education system (Meade, 1984). In such a system, the NESB students face new challenges in new environments and cultures, as Clarkson (1991) has noted “for immigrant students who do not understand the language used by the teacher (who normally comes from a dominant group in society) an immediate barrier is present (p. 5)”.
In addition, parents’ views, beliefs and attitudes can have a considerable effect on the education process. “Parents can agree with educators’ views and take steps to reinforce them in their children. Or they can hold different views and cultivate these in their children (Meade, 1984, p. 6).”

As a consequence, bilingual students may be isolated from mainstream classes due to cultural and linguistic differences.

Up until the 1970s, bilingualism was considered a distinct disadvantage to learning in schools (Clarkson and Dawe, 1994). However, in 1977 Lambert reported that a high level of proficiency in both L1 and L2 could be associated with their school achievement. Since then, the results of various research studies have shown that language proficiency plays an important role in academic achievement and school performance (Cummins, 1979), particularly in mathematics (Dawe, 1983; Clarkson, 1992; Clarkson and Galbraith, 1992; Clarkson and Dawe, 1994, 1996).

The case for investigating mathematics performance in bilingual students is made by Clarkson and Dawe (1994) on the basis that this is an area of great social need, particularly in Australia given the many NESB students in our schools, and the accepted philosophy that competence in mathematics is an important social skill for a liberally educated person (p. 174).

This passage implies that research into the mathematics learning of NESB students in Australia is needed.

2.1.2 Learning mathematics

A number of learning theories have been applied to the domain of mathematics. These are based on the major theories of learning which underlie curriculum planning in the schools and are generally classified into two groups: the “Directed” method and the “Constructive” method (Roblyer and Edwards, 2000, p.3). The Directed method derives from behaviourism (Skinner, 1953) and instructional design (Gagne 1985), while the Constructive method has its basis in cognitive development (Piaget, 1970; Bruner, 1960) and social constructivism (Vygotsky, 1978) (as cited in Roblyer and Edwards, 2000). According to Behaviourism, the teacher provides controlled experiences for students. The fundamental elements of each lesson are taught sequentially and then, a response is expected from the student. While in
constructivist learning, the teacher is seen to be a facilitator who stimulates the students’ critical thinking (Roblyer and Edwards, 2000). As constructivism in its various forms, is currently viewed as the dominant theoretical perspective in this field, this will be elaborated below.

Constructivists believe that students construct their new knowledge throughout an active participation in the learning process. This view has had a major influence on mathematics education in the last two decades (Nickson, 1992; Roblyer and Edwards, 2000, Olivares, 2002). In the constructivist approach, mathematics students should be provided with opportunities to construct knowledge internally; to be able to meaningfully apply knowledge to develop the needed skills, and to promote problem solving through group work (Koehler and Grouws, 1992; Lerman, 1996; Roblyer and Edwards, 2000). This view has recently been expanded to include social interaction as a key component. This is summarised by Kanes (1993) as follows:

in the usual constructivist view of learning mathematics the student is engaged in the active process of constructing meaning for instructionally given target concepts. [While,] Cobb, Yackel, and Wood (1992) and others propound an alternative view, social constructivism, which treats mathematics both as an individual constructive activity, and as a social practice. On this view, learning operates as an individual cognitive action (construction of interpretations) made compatible by social interaction with the collective interpretations of mathematically acculturated practitioners (p. 361).

The social constructivist theory of learning has offered a new perspective suggesting that students should receive opportunities to interact with their peers and teachers to develop their knowledge (Boaler, 2001). The implications of social constructivism for the mathematics learning of bilingual students, particularly when they are engaged in problem solving, either individually or in the classroom, has been raised recently as a major issue (Barwell, 2005). Given the claim by Masingila, Lester and Raymond (2002) that there is a relationship between problem solving and learning:

first and foremost, students should be engaged in the solution of thought provoking problems. Not only should students learn to solve problems, but they should also learn mathematics via problem solving (p. xv),

it is both important and timely to consider the learning process of bilingual students. This will provide a background to the experience of bilingual (NESB) students and their mathematics
performance. Hence, the relevant literature on bilingual students from different ethnic groups in relation to mathematics context, should be considered (e.g., Hewitt, 1977; Meade, 1984; Ainley, Goldman and Reed, 1990; Clarkson and Dawe, 1994, 1996; Clarkson, 1996; Bernardo, 1999, 2002; Bernardo and Calleja, 2005; Latu, 2005, Erktin and Akyel, 2005). The literature on bilingualism and the mathematics performance of bilingual students will be reviewed briefly in section 2.2.

The foregoing also suggests that, for the purposes of this study, it is important to consider the general research related to mathematical problem solving. Schoenfeld (1985, 1992) has developed a comprehensive theory of mathematical problem solving and advocates that understanding and teaching mathematics should be approached through problem solving. This broad area will be considered below.

2.1.3 Mathematical problem solving

Mathematical problem solving is popularly regarded as the broad behaviours that are engaged in when individuals and/or groups solve problems which may vary from what might be regarded as routine, algorithmic exercises to more unfamiliar questions and investigations. In this regard Schoenfeld (1992) claimed that the expression “problem solving” has been used with various meaning, ranging from “working rote exercises” to “doing mathematics as a professional” (p. 334).

Some authors have restricted the definition of mathematical problem solving to the process of “working on unfamiliar problems” (e.g., Schoenfeld, 1992, p. 356), or as a “grapple with new and unfamiliar tasks” (Polya, 1945, 1957, as cited in Schoenfeld, 1992, p. 354), or as behaviours “directed at achieving a goal”, which occurs when students are dealing with solving “a task or situation [that] have no immediately available solution strategy” (Siemon and Booker, 1990, p. 5). During problem solving the student applies “previously acquired mathematical skills and processes in new or unfamiliar contexts” (Linthorne and Doolan, 2003, p. 9). The problem solving process is an organised multi-step task involving understanding the question, choosing a plan, implementing appropriate solution strategy(ies), and reflecting on a performed task (National Council of Supervisors of Mathematics; NCSM, 1989; O’Connell, 2000). In the problem solving process through group and classroom discussions, students can examine a variety of approaches and learn to evaluate appropriate strategies for a given solution. The instructional goal is that
students will build an increasing repertoire of strategies, approaches and familiar problems; it is the problem solving process that is more important, not just the answer (National Council of Teachers of Mathematics, 1989, p. 77).

For bilingual students, solving mathematical problems in a second language, involves two aspects; the mathematical aspect, and the linguistic aspect (Barwell, 2005). A requirement for discussion and/or classroom interaction obliges/causes us to examine the fact that, a problem solver will need to have a reasonable command of language as this will facilitate the students’ ability to understand, and ultimately solve the problem.

Since this study particularly concerns the role of language switching in mathematical problem solving, it will be necessary to consider the literature related to the mathematics problem solving process, in particular, the mathematical and linguistic aspects that affect problem solving. More specifically there is a need to consider the literature on NESB students in this regard (e.g., Clarkson and Dawe, 1994, 1996; Clarkson, 1996; Latu, 2005), which focuses on factors affecting language switching in relation to problem solving. This literature will be discussed in section 2.3.

2.1.4 Role of language in mathematics learning

Language can facilitate more successful learning through the process of social interaction in the classroom. In fact, language plays two major roles in mathematics contexts; in the representation of problem, and in classroom communication (Laborde et al., 1990).

When learning mathematics in schools, students are faced with written formulations by the textbook or by the teacher, with the oral discourse of the teacher in the classroom, and with the talk of their classmates. The content of these statements deals with a wide range of objects, ideas, and activities (Laborde et al., 1990, p. 53).

Learning mathematics, in particular, engaging in the problem solving process, involves different aspects of language such as reading, listening, writing, and discussing. A feature of the language of mathematics text books is,

the use of natural language and of a writing system made of signs exterior to the natural language such as +, x, and <, together with letters or numerals that can be combined according to specific rules in order to create well-form expressions like \( b^2 + c \) or \( a = 4 \). In most cases these symbolic expressions are embedded in sentences written in natural language (Laborde et al., 1990, p. 56).
Teacher-student and student-student communications (interactions) have been viewed as important in mathematics learning, particularly in problem solving (Barwell, 2005). Laborde et al. (1990) also pointed out that, language is used differently in the mathematics classroom depending on the linguistic context. For example, the way a teacher speaks in mathematics classroom differs from the language used in textbooks. The teacher’s speech contains more implicit statements, more ambiguities that often can be cleared up by means of the teacher’s presence, gestures, and possible questions asked by the students. This kind of language has recourse too repetition as every oral discourse does, whereas written mathematical texts avoid redundancy and aim at a concise and compact presentation (Laborde et al., 1990, p. 56).

In the multicultural classroom where bilingual students have to communicate with teachers and other students, these students experience considerable difficulty. Bilingual students face challenges when solving mathematical problems in particular (e.g., Clarkson, 1991; Olivares, 2002; Latu, 2005), and it is suggested that this issue needs to be further examined by teachers (Olivares and Lemberger, 2002). This challenge may be due to the need to understand a problem and access knowledge in the classroom (Darling-Hammond, 1995). In an ESL context, if a bilingual student has proficiency in English this may assist them to understand a mathematical problem, hence improve their achievement.

A consideration of literature on bilingualism and the mathematical problem solving process, leads to and informs a more detailed examination of the role of language in mathematics performance of bilingual students. This will offer a basis for addressing the key research purposes. Literature related to the interaction between language and mathematics performance for these students should be considered (eg, Miura et al., 1988, 1994; Clarkson and Dawe, 1994, 1996, Bernardo, 1999, 2002; Bernardo and Calleja, 2005; Han and Ginsburg, 2001; Wang and Lin, 2005; Latu, 2005), which will be reviewed in section 2.4.

2.2 BILINGUALISM AND MATHEMATICS PERFORMANCE

Bilingualism refers to the use of two or more languages by a person, a group, or a community and may be defined from different viewpoints such as, the political, social or cognitive (Camilleri, 1995). A bilingual individual can be defined as using both languages for means of communication ranging from minimal proficiency in the L2 to equal mastery or fluency in both languages (Collison, 1974). Hornby (1977) stated, bilingualism is not an
In order for bilingual students to develop and share meanings in the multicultural classroom, they must interact with their peers. While in most urban schools many languages are represented by NESB students, English is used as the language of the classroom (Clarkson and Dawe, 1996). Different ethnic groups in an ESL context have different levels of access to knowledge in the classroom (Darling-Hammond, 1995) that may affect (their) school achievement. Differences could be due to linguistic aspects that differentiate bilingual students in relation to time of acquisition of the L2, relative development of the L1 and L2, and relative proficiency in both the L1 and L2. These aspects are described below.

a) Time of acquisition of the L2, for example simultaneous acquisition of two languages by a young infant is called *infantile bilingualism* while *sequential* or *consecutive bilingualism* refers to second language acquisition after the age of three.

b) Relative development of L1 and L2, meaning that sometimes language development may occur simultaneously or be co-existent, as sometimes the bilingual student uses languages separately for different contexts and situations.

c) Relative proficiency in L1 and L2, for example a *balanced bilingual* refers to a person who knows and uses two languages equally well, but other bilingual people may be more dominant in one language than the other. The dominant language in bilingual students may vary for written or spoken purposes (Camilleri, 1995).

Each of the above aspects could determine distinctions between bilingual students in the mathematics classroom. For example, two students who are infantile bilinguals may have different levels of proficiency in either language.

Observation of the classroom activities of bilingual and monolingual students have shown that the process of mathematics learning may exclude bilingual students participation in classroom discourse (Khisty, 1995). In this situation, bilingual students may experience more challenges than monolingual peers in their mathematics learning (Clarkson, 1996; Latu, 2005). Also this disparity affects the bilinguals’ performance compared with their peers. On account of the teacher being a monolingual English speaker, bilingual students are required to swap languages in thinking about their class work (Clarkson and Dawe, 1994, 1996). In this
context, language switching occurs, which is defined as the use of L1 for at least part of the process of solving a mathematics problem (Clarkson, 1996). In most circumstances, it is going to be useful for bilingual students to switch between languages to do their class work in the second language.

Two main aspects of bilingualism in relation to the multilingual classroom are considered in the literature. These are the educational achievement of bilingual students in the classroom (compared to their monolingual peers), and language switching in bilingual students which is common practice in classroom. As this study involved the mathematical performance of Iranian bilingual students in Australia, it is important to review the literature on mathematical performance of bilingual students from different ethnic groups in the Australian context, (section 2.2.1) and, in addition, the use of language switching when bilingual students are engaged in solving mathematical problems (section 2.2.2).

2.2.1 Mathematics performance of NESB students (in Australia)

Prior to the last thirty years, most experts in the field of education assumed that being bilingual was not associated with high levels of school achievement. They thought that, while attempting to use both languages in the classroom, bilingual students “would inevitably have to contend with the confusion between the languages that would certainly ensue” (Clarkson and Dawe, 1994, p. 173).

Results of part of a large longitudinal study, conducted during the 1970s by the Australian Council for Educational Research (ACER) on 10 year-old and 14 year-old students, showed that certain NESB students had significantly poorer performance than their peer group of monolingual English speakers (Hewitt, 1977). Hewitt also found that an important relationship exists between proficiency in reading English and mathematics performance in bilingual students.

However, Meade’s study (1984) on bilingualism and school performance of NESB students in Australia found that two or more languages do not adversely affect academic achievement. One part of this study was conducted with secondary school students in Sydney (Years 9 to 12, from 1974 to 1978) and another part in Queensland (Years 10 to 12, from 1979 to 1981). Through this longitudinal study of school performance, perceptions and experiences of different ethnic subgroups of NESB students were compared with students from an English speaking background (ESB). Results showed that in Sydney, NESB students outperformed
their ESB peers but within the NESB group, Italian, Lebanese and Maltese students had poor school performance compared to Greek and Yugoslav students. In contrast to the Sydney findings, in the Queensland study, ESB students achieved higher levels of performance than the NESB students. A possible reason for the difference in the results between the two cities may be related to different sampling,

as the Queensland school sample includes non-government schools and a rural school and was selected purposively on the basis of SAS [Secondary Allowance Scheme] criteria, it does not parallel the Sydney school sample (Meade, 1984, p. 2).

The role of proficiency of language used (by students), was not considered in this study, so results should be interpreted cautiously.

Meade’s findings are important as they suggested the need for further research on the academic performance of bilingual students. Ainley, Goldman, and Reed (1990) studied 1527 Year 5 and 1559 Year 6 monolingual and bilingual students in Australia. They found that NESB students performed less well on a mathematics test compared to other students. However, this was only statistically significant for Year 6 students. They suggested that “the Year 6 mathematics test was more dependent on language ability than the Year 5 test” (p.89). It should be noted that although ESB students outperformed their NESB peers on the English reading comprehension test, the level of proficiency of the bilingual students in their L1 was not considered in this study, so it was not possible to explore any possible relationship between L1 proficiency and mathematics performance.

Clarkson and Dawe (1994) carried out a longitudinal study involving 700 Italian, Arabic, Vietnamese, and Cambodian bilingual students and 200 monolingual English speaking children in Australia. In this study, students were considered in relation to mathematical problem solving as they progressed from Year 4 to Year 8. Based on previous studies on Papua New Guinea bilingual students by Clarkson (1992), and on four different ethnic groups of NESB students (Italian, Punjabi, Mirpuri, Jamaican Creole) in England by Dawe (1983), they speculated that the level of proficiency in each language for a bilingual student, will effect their mathematics performance, when it involved mathematical problem solving. As a part of the previous (1994-1996) longitudinal study as it related to the Year 4 bilingual Vietnamese students in Melbourne (N=85) and Sydney (N=57), Clarkson and Dawe (1996) explored the relationship between mathematics performance and the level of proficiency in
their L1 and L2. Findings of this study revealed that a high level of proficiency in each language may have a positive effect on performance on mathematical tests.

Although the earlier studies in Australia simply considered all NESB students as a group, Clarkson (1996) and Clarkson and Dawe (1996) compared each ethnic groups’ mathematics performance in the bilingual Year 4 students in Melbourne and Sydney, as well as with their monolingual peer students, when solving mathematical questions. They suggested that different groups of bilingual students should be treated separately to gain any insights that may be related to their culture (Clarkson and Dawe, 1994). The authors (Clarkson and Dawe, 1994) stated that in such studies,

parental educational expectation for their children, …as well [as] information on year of arrival in Australia, common languages spoken in the home, and languages used if helping with school related assignment … have proved useful [to be investigated] (p. 177).

The importance of considering the views and attitudes of the parents of bilingual students was also noted by Meade (1984), for example,

language spoken in the family home, …attitudes to the teaching of ethnic languages, … parents’ influences on [students’] hopes for future education and jobs, … NESB family cohesion and solidarity, and unity of family purpose in relation to children’s futures [are important] (pp. 3, 117).

Based on these statements (by Clarkson and Meade) it would seem that parents' attitudes may have an impact on the use of L1 in different situations such as learning mathematics in classrooms. Parents’ expectation also may have some influences on their children future life. This consideration has to be noted in research involved with bilingual students as the information of parents’ view that outlined above may provide a rich (an enriching) insight into the use of L1 when solving mathematical problems.

2.2.2 The use of language switching by NESB students

Language switching or code-switching refers to the “use of more than one language in the same conversation” (Adler, 2001, p. 73). In a bi-/multilingual mathematics classroom language/code-switching occurs, when students are learning in an additional language. Recent mathematics education research in bi/multilingual settings, have focused on language switching (LS) and the extent to which this impacts learning. For example, Moschkovich
Ch.2 – Literature Review

(1996) and Khisty (1995) in the USA, and Ndayipfukamiye (1994) in Burundi and Setati (1996) in South Africa have all reported various ways “in which switching between the learners’ main language and English (or French) by the teacher enhances the quality of mathematical interactions in the classroom” (Adler, 2001, p. 75).

Adler (2001) referred to a study on Year 4 students in South Africa (Setati, 1998), where the language of learning and teaching was English. In these classrooms both teachers and students switched to their language (Setswana) in calculational mathematical discourse. They reported that learners communicate their mathematical thinking more easily in Setswana language but they also have to learn mathematics in English. Hence, this switching improves the feature of mathematical interactions in the classroom. Vithal (2005) reported the results of a series of studies conducted on primary students in South Africa, in Cape province (Ncedo, Peires & Morur, 2002), and KwaZulu- Natal province (Adendorff, 1993) that language switching is used “to enable both learner-learner and learner-teacher interactions” (p. 93). Adler (2001) has also noted that:

As research and development in language and learning in bi-/multilingual settings has shifted from regarding the learner as in some way deficient to embracing the presence and use of more than one language in teaching and learning as resource, so code-switching has become a taken-for-granted ‘good thing’ (p. 75).

As previously mentioned (section 2.2.1), the studies conducted by Clarkson (in Melbourne) and Dawe (in Sydney) in the 1990s, explored the relationship between mathematics performance and bilingualism. They published several papers (Clarkson, 1996; Clarkson and Dawe, 1994, 1996) and compared NESB students (from various ethnic groups) with each other, as well as with their ESB peers.

Clarkson and Dawe (1994) speculated as to the occurrence of language switching among NESB students engaged in mathematical problem solving. They also conjectured some possibilities, which may prompt language switching.

There are a number of possibilities including the following. Do students simply have a preferred language in which they wish to work when it comes to mathematics? This may occur because they habitually use their first language in most situations except when in the classroom in their first language. A further possibility deals with the perceived difficulty of a problem. Does this prompt students to switch languages? … A third possibility seems to be a rich situation to explore, that of the mathematical context. Will there be a variation if students...
are confronted with symbolic algorithmic items, with routine mathematical word problems, or with open-ended mathematical questions? (Clarkson and Dawe, 1994, p. 175)

Based on this speculation, they reported later (1996) that bilingual students switch between languages when performing different types of mathematics questions (symbolic, open-ended or novel, word problems). They also found that language switching occurred more in word problems than in other types of problems because the linguistic demands of word problems are different from symbolic questions. For instance,

the arithmetic problem solving of bilingual students was poorer with the word problems in both first and second languages compared with the same problems presented in a purely numeric (symbolic) format (Bernardo, 2002, p. 293).

As part of the longitudinal study, which is mentioned in the previous section, Clarkson (1996) reported the findings for two ethnic subgroups including 80 Vietnamese and 32 Italian bilingual, Year 4 students in Melbourne. He found that the Vietnamese NESB students used more L1 to solve the mathematical items - which involved symbolic, word and novel problem formats - than the Italian NESB students (Table 2.1).

<table>
<thead>
<tr>
<th>Math Tests</th>
<th>% of students using L1 for at least one item</th>
<th>% of students using L1 for all items</th>
<th>% of students using L1 for no items</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Vietnamese</td>
<td>Italian</td>
<td>Vietnamese</td>
</tr>
<tr>
<td>Symbols</td>
<td>43</td>
<td>22</td>
<td>14</td>
</tr>
<tr>
<td>Word Problems</td>
<td>53</td>
<td>28</td>
<td>9</td>
</tr>
<tr>
<td>Novel Problems</td>
<td>41</td>
<td>28</td>
<td>8</td>
</tr>
</tbody>
</table>

Results revealed that language switching for at least one item by the Vietnamese and Italian bilingual students occurred, more in word problems than in other type of questions.

In a study of 42 senior (Year 12) bilingual Pasifika students in New Zealand, Latu (2005) found that these students experienced difficulty due to the complexities of the mathematical sentences, which in turn prompted language switching. His findings indicated that, “[language] switching is a common practice for the bilingual students in their classrooms” (p. 489).
2.3 FACTORS AFFECTING MATHEMATICAL PROBLEM SOLVING

The literature relevant to mathematical problem solving is too large to review in the context of this study. As mentioned at the beginning of this chapter (section 2.1.3), some mathematics education researchers have stated that problem solving is a process involving working on rote exercises or unfamiliar conditions. (Schoenfeld, 1992). Siemon and Booker (1990) have claimed that problem solving occurs whenever students want to work on a problem for which they have no immediate available solution strategy. Problem solving,

in the spirit of Polya is learning to grapple with new and unfamiliar tasks when the relevant solution methods (even if only partly mastered) are not known (as cited in, Schoenfeld, 1992, p. 354).

Any problem may be defined as a routine or genuine question, depending on why, how and when it is used, and (the student) who is trying to solve it.

Notice that, having a problem is a very personal phenomenon [sic]. It depends on who you are, what you know and how you feel about the task in question (Siemon and Booker, 1990, p. 5).

For example, although a task that engages a Year 1 student actively in the learning process may be regarded as a problem for that student, the same task may not sensibly be regarded as a problem for a Year 5 student.

Problem solving is regarded by many as the central focus of a mathematics curriculum (O’Connell, 2000). Schoenfeld (1992) also maintained that problem solving is at the “heart of mathematics” and presented Polya’s approach to problem solving.

The mathematician best known for his conceptualisation of mathematics as problem solving, and for his work in making problem solving the focus of mathematics instruction, is Polya. Indeed, the edifice of problem-solving work erected in the past two decades stands largely on the foundations of his work (Schoenfeld, 1992, p. 339).

The mathematical problem solving has been described in terms of five steps by O’Connell (2000). These are presented in Table 2.2 below.
Table 2.2: O’Connell’s five steps in problem solving (Adapted from O’Connell, 2000, p. 69)

<table>
<thead>
<tr>
<th>Steps</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Understanding the Question</td>
<td>What is the problem you are being asked to solve?</td>
</tr>
<tr>
<td>2. Choose a Plan</td>
<td>What strategy will you use to solve the problem?</td>
</tr>
<tr>
<td></td>
<td>What do you think the answer will be?</td>
</tr>
<tr>
<td>3. Try your plan</td>
<td>Try your strategy to solve the problem.</td>
</tr>
<tr>
<td>4. Check your answer</td>
<td>Does your answer make sense?</td>
</tr>
<tr>
<td></td>
<td>Are your calculations correct?</td>
</tr>
<tr>
<td>5. Reflect on what you’ve done</td>
<td>Why did you pick the strategy you did?</td>
</tr>
</tbody>
</table>

Lerman (2001) has described the elements of problem solving in terms of negotiating ‘mathematics meanings’, ‘the use of mathematic language’, and ‘the use of strategies’. All of these are “the tools with which students think and speak mathematically” (p. 107).

Given the above viewpoints, difficulties in problem solving may be related to the problem solving process. On focussing on the relevant literature in the bilingual context, suggesting that in turn, problem difficulty may prompt language switching (Clarkson, 1996; Clarkson and Dawe, 1994, 1996; Latu, 2005). There are two major aspects of difficulty which are likely to have an impact on bilingual students’ problem solving ability. The first aspect is difficulty with problem comprehension (Clarkson, 1996; Clarkson and Dawe, 1994, 1996; Bernardo, 1999, 2002), which is discussed in section 2.3.1. The second is difficulty with implementing an appropriate strategy or algorithm (Clarkson, 1996; Latu, 2005), as is discussed further in section 2.3.2.

### 2.3.1 Difficulty with problem comprehension

Any student, irrespective of language background, may sometimes experiences difficulty with comprehending the written text of a mathematics question involving natural language and /or mathematics signs, so they are not able to continue solving a mathematics problem. This difficulty may be attributed to difficulty in reading the problem or understanding the concepts, which needs to be extracted from the problem statement (Laborde et al., 1990). For bilingual students, language switching may occur at the stage of comprehending the problem (Clarkson and Dawe 1996; Latu, 2005). However, they may still not be able to solve the problem due to a lack of conceptual understanding. It will need effective application of prior mathematical knowledge to choose an appropriate strategy (O’Connell, 2000; Linthorne and Doolan, 2003).

The two steps of difficulty with problem comprehension: *difficulty in interpreting*
language/symbols in problem statement and difficulty in interpreting concepts relevant to/ or needed to solve a task are discussed (reviewed) below.

**Difficulty in interpreting language/ symbols in problem statement**

Results of several studies on bilingual students (Clarkson and Dawe, 1994, 1996; Clarkson, 1996; Bernardo, 1999, 2002, Bernardo and Calleja, 2005, Latu, 2005; Erktin and Akyel, 2005) have revealed that mathematical problem solving is not purely an abstract and decontextualized process, but is affected by factors such as language use. During the mathematical problem solving process, bilingual students may use their L1 to facilitate comprehension (Clarkson and Dawe, 1994, 1996). Experiencing difficulty in interpreting language or symbols in problem statements in L2, could undermine bilingual mathematics competency. This issue is more prominent when the mathematical problem is stated in a word format, which may restrict the student’s ability to proceed towards other steps of the solution process including making a plan, or choosing a strategy (Bernardo, 2002).

In exploring the relationship between language and mathematics problem solving, Bernardo (2002) conducted a study on 92 Year 2 bilingual students in the Philippines. This study involved 48 students whose first language was Filipino and 44 students whose first language was English. Bernardo reported that bilingual students, who are faced with mathematics word problem texts in their L2, experience more difficulty understanding the question compared to their peers who process word problems in their L1. Bilingual students’ understanding and solving of a mathematical word problem in an EFL context improves when the text is written in their L1. Bernardo (2002) presented the L1 advantage to be as follows:

> the students were better able to understand and solve problems in their first language, whether the first language was English or Filipino. Moreover, the advantage was more marked with the easy [word] problems (p. 283).

Consequently, language switching may be more likely to occur when difficulties arise, as Clarkson and Dawe (1996) reported that “if the student feels the item is difficult because of meaning not being clear, when reading or comprehending the problem, a switch [to L1] may occur” (p.159).

For instance, Latu (2005) reported difficulty in interpreting some mathematical signs such as > (greater than) or < (less than) among New Zealand bilingual students. He concluded that the complexities of mathematical questions “provide extra challenges for these students
…[and] play a major role in the language features that impede Pasifika students’ learning of mathematics” (p. 489).

Furthermore, Clarkson (1996) reported that solving word problems was more difficult than in the case of symbolic questions due to difficulty in understanding the language used in the problem. Thus, it remains to be seen whether or not this is the same issue for Iranian NESB students.

**Difficulty in understanding concepts related to/ needed to solve a task**

After reading a mathematical question, a problem solver needs prior knowledge to be able to interpret concepts related to the mathematical problem. According to O’Connell (2000), student ability to use a correct operation or algorithm can often be a reflection of the way in which they were taught each operation. Students who memorize math facts without developing a clear understanding of the concepts may have more difficulty identifying when each operation should be used than those students who developed an understanding of each concepts through demonstrations, explanations, and hands-on experiences (p. 19).

Conceptual understanding is achieved through the “transfer” of knowledge leading to an understanding of the new circumstance which is different to the circumstances in which that knowledge was developed (Schoenfeld, 1992).

The construction of the problem interpretation is done by students in interaction with their ability to develop a solution strategy. The student’s interpretation … is likewise based on hypotheses elaborated by the student about the mathematical content that are dependent on his or her mathematical knowledge (Laborde et al., 1990, p. 68).

If the problem solver cannot construct a relevant plan in that situation, they will not be able to carry out a task properly. Therefore, an appropriate understanding of the mathematics concepts of a problem facilitates implementing the skills, and strategies necessary. Difficulty arising in conceptual understanding of a problem during the solution process in bilingual students is more dependent on their mathematical knowledge than their proficiency in their L1 and/ or L2.
2.3.2 Difficulty with implementing an appropriate solution strategy/algorithm

As explained in section 2.3.1, the first step in successfully solving any mathematical problem is to develop an understanding of the language in the problem statement. It is also important for students to choose the appropriate operation or strategy to deal with the problem based on prior knowledge (O’Connell, 2000). The phase outlined above is followed by the implementation of the chosen strategy as discussed here.

In primary years mostly the basic operations (algorithms) are applicable in the mathematical problem solving process. To implement these basic algorithms, the students’ prior knowledge has been viewed as an important issue to successfully solving the problem. As Masingila, Lester and Raymond (2002) have claimed,

>a solid understanding of addition, subtraction, multiplication, and division is crucial to being able to do mathematics, and these operations play central parts in the elementary school mathematics curriculum (p. 71).

Difficulty in solving a problem in bilingual students may arise while implementing the chosen strategy. For example, Latu (2005) in a study on bilingual students in New Zealand (section 2.2.2) reported that it is difficult for these students to implement strategy/algorithm. This solution strategy is defined below, as being able to,

>carry out appropriate computation, … appropriate problem solving strategies… [that] provide the comprehension skills needed to successfully make sense of and solve mathematical word problems (Latu, 2005, p. 489).

As a result, there may be some difficulty or inability to make progress in the solution process, while implementing a chosen strategy may prompt language switching (Clarkson and Dawe, 1996; Latu, 2005).

2.4 LINGUISTIC FACTORS AND MATHEMATICS COMPETENCY OF BILINGUAL STUDENTS

Reference to the wide ranging literature on the analysis of language in the mathematics classroom is needed to inform this study (see, for example, Ellerton and Clements, 1991). The interaction between language and mathematics learning plays an important role in the mathematics classroom in which bilingual students are engaged in the student-student and student-teacher discourse. In a constructivist classroom context, “mental representation” and
the “linguistic features” of the mathematics problem solving process are important. As Laborde et al. (1990) have stated,

some studies mention that a positive outcome is not guaranteed solely by the verbal interaction between students; the features of the task, the relative status of the students, …, and their language proficiency affect the interaction and its effect on the [problem] solving process (p. 66).

In a multicultural context, the language, as represented by the bilingual student for “comprehending: the question, and the “linguistic features” used in statement of the problem are important in solving mathematical problems. As bilingual students may use L1 and L2 for solving problems (Clarkson, 1996), and given a reasonable (prior) mathematical knowledge, high proficiency in both languages could have a positive effect on problem comprehension that may lead to greater competency in mathematics. Therefore, it is important to consider the relationship between proficiency in both languages and mathematics performance as is discussed in section 2.4.1. The first language of bilingual students could affect “thinking and mathematics achievement” (Wang and Lin, 2005). In addition, high proficiency in L1 can facilitate bilingual students’ comprehension of mathematics problems. The relationship between the nature of the L1, in terms of linguistic factors such as structure of L1, explicitness of L1, and vocabulary of L1, and mathematics performance will be considered in section 2.4.2. The role of language, in which the problem is stated is important for “conveying and portraying mathematical ideas” (Wang and Lin, 2005). As the previous literature showed (see 2.3.2), bilingual students experience more difficulty with word problems than symbolic questions due to their linguistic demands. Therefore, the clarity of the language used in the problem may facilitate comprehension of the problem, which in turn can lead to success in the problem solving process (Bernardo, 1999, 2002). The clarity of language, in which the mathematical problem is stated will be discussed in section 2.4.3.

2.4.1 Role of language proficiency in educational achievement, including mathematics

In the last few decades, the positive influence of bilingualism on academic performance under certain circumstances has been reported on. For example, Lambert (1977) found that bilingual students with proficiency in both languages (L1 and L2) had a higher level of educational achievement than their matched, monolingual peers. This is supported by Cummins (1979) who showed that a high level of proficiency in both languages is critical for academic achievement. Cummins’ theory is explained in more detail below.
Cummins’ Theory

Cummins (1979) proposed the “threshold” hypothesis to account for the role of language proficiency in academic performance. Cummins’ theory is based on the links between cognitive tasks and educational performance. This theory indicated that there may be a minimum or threshold level of proficiency of L2, which may lead to a high educational performance in bilingual children. In this regard, balanced bilinguals - students with a high level of proficiency in both languages - outperformed their monolingual counterparts across all areas of the school curriculum. This level of performance, which indicated a cognitive advantage, is associated with the upper threshold of proficiency in L2. At the same time, the children with a low proficiency in both the L1 and L2 showed a lower level of school performance than the students who were proficient in one of the languages (one-dominant bilingual). This second group represents the lower threshold of proficiency in L2, while the second language is replacing the first language (Cummins, 1979, 1991; Cummins and Swain, 1986). This hypothesis refers to the impact of the learning environment on the level of language proficiency and cognitive functioning in bilingual students. In an attempt to explain this relationship, Cummins (1979, 1991) defined two learning environments: additive and subtractive environments.

An additive environment refers to an environment in which the student has a strong first language (L1) proficiency and where the “L2 is being learned to add to the repertory of skills” (Clarkson 1991, p. 13). In an additive learning environment, balanced bilingual students with a high level of competency in the second language (L2) seem to have a cognitive advantage and outperform their monolingual peers (Clarkson, 1991). In a subtractive environment, where the original language (L1) of the student is being replaced by the L2, bilingual students with low competency in their second language (L2) “are even worse off [on school performance] than students who are clearly dominant in one of the languages” (Clarkson 1991, p. 13).

Based on these definitions, Cummins defined two categories for his threshold theory: an upper and a lower (see Figure 2.1). An upper threshold refers to the educational performance of balanced bilingual students in an additive environment, while, a lower threshold refers to the educational performance of bilingual students with a low proficiency in either language in a subtractive learning environment. There is also another educational environment that is neither additive nor subtractive with neither positive nor negative cognitive effects. This level of bilingualism applies to bilingual students who are more proficient in only one of their
languages, either the first or second language. However, this group outperformed the other students (their peers) with a low proficiency in both the L1 and L2 (Figure 2.1) (Cummins, 1979; Clarkson, 1991)

Figure 2.1: Level of bilingualism and different learning environment (Adapted from Clarkson, 1991)

<table>
<thead>
<tr>
<th>The level of Bilingualism attained:</th>
<th>Positive Cognitive effects</th>
<th>Upper Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Additive</td>
<td></td>
<td></td>
</tr>
<tr>
<td>One language dominant</td>
<td>Neither positive nor negative cognitive effects</td>
<td></td>
</tr>
<tr>
<td>Subtractive</td>
<td>Negative Cognitive effects</td>
<td>Lower Threshold</td>
</tr>
</tbody>
</table>

During the past decade, the study of bilingualism and language proficiency has mostly focussed on acquisition of the second language. The relationship between proficiency in the L1 and L2 of bilingual students and their academic performance has also been considered in recent literature (Cummins, 2000). In these students, language proficiency appears to play an important role in learning and educational achievement. More specifically, a number of studies have addressed the mathematics performance of bilingual students in terms of proficiency in both languages (Clarkson and Dawe, 1994, 1996; Clarkson, 1996; Bernardo, 1999, 2002; Bernardo and Calleja, 2005; Latu, 2005; Erktin and Akyel, 2005). These will be discussed briefly below.

In support of Cummins’ theory, the Clarkson and Dawe (1996) and Clarkson (1996) studies, which are explained in section 2.2.1, found that balanced bilingual students with a high proficiency in both languages (upper threshold) outperformed their monolingual peers. However, those students with a low competency in both languages (lower threshold) did not perform as well as monolingual students or those with competency only in one language only. These results further support Cummins’ threshold theory.

Similarly, Erktin and Akyel (2005) in a study of 250 Year 8 bilingual Turkish students in an EFL context reported a positive relationship between reading comprehension and mathematics performance. The Turkish bilingual students who were highly proficient in both L1 and L2, outperformed their peers with a low proficiency in both languages in the mathematical test presented in the L2, supporting the Cummins’ upper threshold hypothesis. In addition,
Bernardo (1999, 2002), and Bernardo and Calleja (2005) reported better mathematical performance in terms of problem solving in students who had a high level of language comprehension skills. The findings outlined above suggest that the students’ level of proficiency in both their L1 and in English, the language of their usual schooling, may influence mathematical performance, particularly in problem solving.

2.4.2 The nature of first language

Different languages have a different structure, vocabulary, and pronunciation, writing and reading styles. For example, Persian (Farsi) and English show distinct differences in syntactic and orthographic structures (Arefi, 1997). Persian has 32 letters in the alphabet and is written from right to left. Verbs are put at the end of Persian sentences, while in English verbs are often presented after the subject. The Sapir–Whorf hypothesis stated that the structure of a language affects the way we think and perceive the world (Clarkson, 1991; Wang and Lin, 2005). Some studies as presented below explored the impact of the first language, in particular its structure, explicitness, and vocabulary on mathematics achievement.

Language structure

Miura et al.’s (1988, 1994) studies have shown that in the beginning months of first grade, Chinese, Japanese and Korean students outperformed their American, French and Swedish peers in constructing symbolic numbers. The authors concluded that the congruence between the base-ten numeration system and the number naming systems in the Chinese, Japanese and Korean languages (which do not have any parallel in the English, French and Swedish languages) led to this achievement. In order to show this congruence in the Chinese language, it can be seen that the number 5 is called wu and 10 is called shi, so number 15 is called shi wu and number 50 is called wu shi. While, in the Persian language the combination of numbers is more consistent with English. For example, 5 is called panj and 6 is called shesh, so number 56 is called panjah-o-shesh. Another example is for the number 78, as 7 is called haft, and 8 is called hasht, and 78 is called haftad-o-hasht (-o- is a connection word, which means and) while, 87 is called hashtad-o-haft. This suggests that Persian students may experience some conceptual difficulty interpreting 2 digit numbers in a way similar to their English only speaking peers.

Explicitness of language

Another influence of the first language on mathematics performance is related to the linguistic clarity with which mathematics concepts are portrayed (Wang and Lin, 2005). Better clarity
of a language, in this instance Chinese, rather than in English, may contribute to a better understanding of mathematics, especially in the case of unfamiliar concepts (Wang and Lin, 2005). For example, a study was conducted by Han and Ginsburg (2001) on Year 8 students comparing 29 Chinese bilinguals, with 20 English monolingual and 33 Chinese monolingual students when they were solving mathematical problems. These problems contained unfamiliar words related to the mathematical concepts, in both the Chinese and English languages. The Chinese bilingual and monolingual students outperformed their English monolingual counterparts. Findings suggest that the meaning of words in the Chinese language, are more explicit compared to these in the English language, hence they supported the mathematics competency of the Chinese students (Han and Ginsburg, 2001).

There is a long history behind mathematics in Iran. Prior to Alexander the Great (6th century B.C.), the Iranian civilization had an elaborate system of mathematics and there was a major contribution by Iranian mathematicians to mathematics, particularly in algebra (for example, the work by Khayyam - see Behzad, 2005; Iran Chamber, 2005; and Ghorbani, 1986). The mathematics of China has a history similar to that of Iran. However, there is no study to show the effect of/relationship between the use of the Persian language and mathematical problem solving, as was the case for the Chinese language.

**Vocabulary for presenting mathematical concepts**

In some languages it is more difficult to describe mathematical concepts and principles than it is in the English language. For example, in the Pasifika languages in New Zealand (including the Tongan and Samoan languages), there is no vocabulary to express some mathematical terms and ideas that play a key role in learning in the mathematics classroom, for example, ‘divisor’, and ‘denominator’ (Latu, 2005). Thus these students need, the transliteration of English words that are phonetically translated into the Pasifika languages such as: "sikuea" for "square" (Latu, 2005, p. 484).

Moreover, due to the great social and cultural differences between Western and Tongan societies, mathematical terms and concepts such as “absolute value”, and “standard deviation” are not able to be clearly defined in the Tongan language (Fasi, 1999, as cited in Latu, 2005, p. 483). Hence, for Pasifika students, contextualizing the learning of mathematical words is a more demanding task (Latu, 2005). Additionally, combining mathematical terms, each with a unique concept, in a complex phrase to form a new
concept, for example “least multiple”, and “twice as much” may confound comprehension of the new concept. This difficulty could also be highlighted in word problems, as Latu (2005) has stated:

mathematical word problems provide some of the more cogent examples of mathematics discourse features at work. Processing sentences in such a linguistically dense context, coupled with the logical nature of many mathematical problems, requires the reader to rely on the sentence to convey clear and unambiguous meanings (p. 484).

However, this is not consistent with some other languages. For example, in the Persian language there are often two or three similar words for each mathematical term, particularly basic mathematical operations involved in the primary mathematics classroom. For example, for subtraction (or minus, or take away) there are *tafrigh* (or *menha*, or *bebar*), respectively in the Persian language. This is similar to that of the English language with the use of subtraction or take away. Because of the long history of mathematics in Iran, there is a specific term for each mathematics concept in the Persian language. It is not known to what extent the existence of these terms supports/ hinders Iranian students involved in an ESL context.

### 2.4.3 Clarity of the language used in word problem

Word problems are considered an important part of mathematics education, (Verschaffel, Greer, and De Corte, 2000) and this has been demonstrated in recent studies measuring students’ mathematics achievement globally (TIMSS, 2003). Being able to solve word problems can indicate the possession of knowledge and skill relating to associated "real-world" situations (Bernardo, 1999, 2002; Bernardo and Calleja, 2005). As previously mentioned (see section 2.3.1), word problems have a basic linguistic component which affects the solution process. This process includes the formation of an accurate mental representation, comprehension, thinking, analysing and a correct solution to the problem (Clarkson, 1991; Bernardo, 2002). The findings of these studies suggest that the language in which the text problem is written affects the solution process.

Studies conducted on primary students by Verschaffle, De Corte and Lasure (1994) in Belgium, Yoshida, Verschaffèl and De Corte (1997) in Japan, and Bernardo and Calleja (2005) in the Philippines, used a similar testing instrument for the study of several groups of primary students. They administered a test including several pairs of word problems. The first problem of each pair was simple without any unclear text. Thus students could solve the
problems with one or two arithmetic operations. The second problem of each pair was more complex than the first and could be solved in a number of ways. For example,

John has bought one plank of ten meters. How many planks of one meter can he saw out of this plank?

is a simple format, and

John has bought 4 planks of 2.5 m each. How many planks of one meter can he saw out of?

is a more complex one. Most students answered both question types with the same answer of “10 planks”. They reported that common to students from different countries across different languages, there was a "stereo-typed" response and "non-realistic" approach to solving the mathematical word problems above. This finding suggests that understanding the word problems mainly depends on the transparency of the problem statement: how difficult is it to comprehend the statement of the problem, and how difficult is it to identify an appropriate method for solving the problem? For example,

the language in which [mathematical] word problems are stated affects how bilingual students apply their knowledge, procedures, and strategies for solving the problem. … Understanding [linguistic factors affected problem solving] should guide the development of alternative pedagogies for developing useful and applicable mathematical knowledge among [bilingual] students (Bernardo & Calleja, 2005, pp. 126-127).

In another study Bernardo (1999) re-worded the mathematical problems with minor revision in the instructional materials in both the English and Filipino languages. In this case the mathematics problems were presented in a conventional and re-worded format. For example, the conventional format was:

Jose won 3 balls. Now he has 5 balls. How many balls did Jose have in the beginning?

and the re-worded format was:

Jose has some balls. He won 3 more balls. Now he has 5 balls. How many balls did Jose have in the beginning?

The result of this study showed that the re-wording facilitated problem solution, although
the effect of re-wording was mediated by the effects of the language; and the effects of the language also varied between the high- and low-achievement students (Bernardo, 1999, p. 149).

It can be concluded that, in a bilingual context, better comprehension and subsequent solution processes are more likely to occur when mathematical problems are presented in such a way as to clarify the relationship between the known and unknown quantities of the problem.

Poor performance by bilingual students in word problem solving does not necessarily indicate that they do not have computational and conceptual skills in mathematics. Rather, it may be related to the linguistic factors, as Bernardo (1999) has stated:

difficulties that students have in understanding and solving word problems in mathematics may be brought about by their difficulties with the English language, among others. Hence, the language of instruction may be creating noise in the learning process (p. 160).

2.5 SUMMARY

Problem solving is the central part of mathematics teaching and learning. A successful problem solver has to interact with the teacher and with the other students through classroom discourse. This classroom discourse involves the natural language as well as the mathematical terms and signs (language). In multicultural classrooms bilingual students are often unable to participate actively and successfully in the discourse patterns of mathematics classrooms. As a consequence, these students may not perform as well as their mono-lingual peers.

Given the increasing number of immigrant families in Australia, it is not surprising that there has been a number of recent studies investigating the mathematics performance of bilingual immigrant children. Originally bilingualism was assumed to be a disadvantage for educational development, including mathematics. However, after the 1970s research showed that proficiency in both languages may be associated with mathematics performance in bilingual students. Clarkson and Dawe conducted a longitudinal study on several bilingual ethnic groups in Australia (1994, 1996). They explored the fact that language switching is a common practice when bilingual students are solving mathematical problems. They also found that the difficulty of mathematics problems is a major reason for language switching.
The question underpinning this research is how does both the L1 and L2 influence the mathematics performance of bilingual students when they are solving mathematical problems? Language may impact different areas and aspects of mathematical problem solving. Firstly, according to Cummins's (1979, 1991) theory and the studies by Clarkson (1991, 1992, 1996), Clarkson and Galbraith (1992), and Clarkson and Dawe (1994, 1996) the level of language proficiency in the L1 and L2 of bilingual students may have a relationship with the level of mathematical performance. Secondly, based on the “Sapir-Whorf” hypothesis the nature of the first language and clarity of the language used to state the mathematics affects thinking and hence the analysis of the mathematical problems (Clarkson, 1991; Wang and Lin, 2005).

In the bilingual context, for exploring school achievement, in general, and mathematics performance, in particular, Clarkson and Dawe (1994) recommended that different groups be considered separately.

Unlike the few earlier studies in Australia which made no distinction on the basis of language, but simply treated NESB students as a group, we believe it important to treat such groups separately in the first instance to gain any other insights that may be pertinent to each culture (Clarkson and Dawe, 1994, p. 174).

In a way similar to the Clarkson and Dawe study (1994), I was interested in exploring the role of language switching when Iranian NESB students are solving mathematics problems. To the best of my knowledge, there is no literature regarding language switching by Persian NESB students, their proficiency in L1/ L2, and their mathematics competency. Arefi (1997) conducted the only other study on 70 Iranian NESB Year 3, 4, and 5 students in Australia. Similar to the students of the current study, these students attended NSW State primary schools during week days and Persian schools on weekends. However, her study investigated the role of L1 literacy in L2 acquisition. Arefi found that English language writing development “relies strongly” on Persian language proficiency (p. 232). She also reported that

Writing skills in English (L2), in a bilingual milieu (Australia), among Iranian primary school children who were instructed in their first language and at the same time attended regular Australian schools, appear to be related to Farsi (L1) writing skills (1997, p.231).
The findings of her study, which implied that Persian language writing skills could be transferred to the English language, support Cummins’ interdependence hypothesis (1979, 1991).

Nevertheless, there remains a gap in the literature regarding knowledge about the role of language switching in the mathematical problem solving of Iranian bilingual students in the Australian context. As the objectives of this study are similar to those of the Clarkson (1996) investigation, it was decided that it would be useful to replicate Clarkson’s (1996) study with a small group of Iranian NESB students in the Australian context. Hence it was decided that the central aim of this study would become to explore the role of language switching in mathematical problem solving. In particular, the research questions to be addressed by this study are:

1. To what extent do Year 4/5 Iranian NESB students use language switching while solving different types of mathematical problems?
2. What factors prompt language switching (if any) in this sample of bilingual students?
3. Is there any relationship between proficiency in the L1 (Persian) and L2 (English) languages and mathematics performance/competency?
4. What, if any, relationship exists between parents’ views and students’ backgrounds (details) and language switching?

Based on the results of the increasing number of studies in the bilingual educational context, the linguistic factors outlined above may help to provide insight into the development of new teaching strategies for bilingual students in mainstream or bilingual education contexts. This may facilitate students' competence in mathematical problem solving.
In the previous chapter, I reviewed literature from a range of studies dealing with bilingual students and literature related to mathematics problem solving in primary aged children. This literature revealed that there were some relationships between linguistic factors and mathematics competency for different ethnic groups of Non-English Speaking Background (NESB) students.

The main objective of this study was to explore the role of language switching (LS) in a group of Iranian bilingual Years 4 and 5 students while solving mathematics problem in an ESL (English as the Second Language) context. The reasons for language switching also were considered. This chapter will discuss the methodology adopted, to address the aims of the study. This is presented in three main sections. In the first section (3.1), justification of the choice of research method will be discussed. Then in the second section (3.2), a pilot study will be presented. The third section (3.3), the main study, will deal with participants, procedures, instruments, and the different types of data analyses.

3.1 DESIGN

Qualitative approach
In order to address the research questions, that is, incidence and reasons of language switching, relationship between mathematic competency and language proficiency, and the relationship between students’ backgrounds and language switching, a qualitative research approach was considered to be the most appropriate methodology. A qualitative research approach can explore how a specific group acts in a particular situation (Burns, 2000). An in-depth investigation of issues is facilitated by qualitative methods. As Patton (2002) claimed, Qualitative methods typically produce a wealth of detailed information about a much smaller number of people and cases. This increases the depth of understanding of the cases and situations studied, but reduces generalizability (p. 14).

To illuminate the research questions of this study, a qualitative case study methodology was selected as it allowed the investigator to focus on a specific group or system – “an entity in itself” (Burns, 2000, p.460) and refers to an investigation of a single unit or case. This case may be an individual, a school, an organization or a particular group (Stake, 2000). However, the specific case should be bounded and be clearly defined (Stake, 2000). The main focus of a


A case study is to gain a wealth of detailed information on a small sample size that is selected specifically (Patton, 2002). In this instance, the case was limited to 16 students in Year 4 or 5 who were studying in Victorian primary schools during weekdays and attending Persian language schools on Saturdays. In purposeful sampling, the information-rich cases are studied to illuminate the research question (Patton, 2002). In this study, I aimed to examine and establish a deeper level of understanding of the practice of language switching in Iranian NESB students, while they were solving different types of mathematical problems.

Through this kind of research design, factors that might prompt language switching, such as the type of mathematical problem, and degree of item difficulty (Clarkson & Dawe, 1994, 1996; Clarkson, 1996), could be explored. A semi-structured interview was used to explore the incidence of language switching during mathematical problem solving. The relationship between students’ level of proficiency in the Persian and English languages and their mathematics competency and the influence of out of school factors, such as parents’ views and students’ background on language switching were also investigated. To the extent that this study considered parents’ views and beliefs on using language(s), this case study has some ethnographic aspects (ethno culture, graph description) (Stake, 2000).

This study largely replicated Clarkson's study (1996) with Iranian bilingual students. However, instead of videotaping the interviews, I provided a language checklist with an answer sheet so that each student could record the language(s) used while solving mathematical problems. This helped students to remember the events of language switching (if any). Before doing the main study, I conducted a pilot study to trial the chosen instruments and improve my skills as an interviewer. Since I am an NESB student, one of the major reasons for conducting the pilot study was to develop my language skills in English as an interviewer. Furthermore, in order to select the most appropriate instrument(s) and the analysis for the main study, I trialled the instruments by reviewing the results (of) the pilot study. The pilot study is described in the next section.

3.2 PILOT STUDY

The pilot study was conducted on four Iranian NESB students in Year 3 or 4. The following sections detail the methodology used in the pilot study.
3.2.1 Participants
The pilot study included four students in Year 3 or 4, who were chosen through personal approach. They were the children of my relatives and friends. The two male students were in Year 4, and the two students who were females were in Year 3. All were students at Australian government schools. Three of these students started their schooling in Australia and have lived here for up to 6 years, while the remaining student started his Australian schooling in 2004. They spoke in Persian as their first language (L1) and their second language was English (L2).

3.2.2 Procedure
After gaining the parents’ consent, I interviewed the students individually at their homes on different days. In the first part of interview, ten mathematics questions, selected as appropriate from a pool of mathematics questions (see Appendix A), were administered to each student in English. A language-switching checklist (LS Checklist) was provided with the answer sheet to record the language(s) used when solving mathematical problems. I asked each student to record the language(s) used for each question immediately after solving that problem. In the second part of the interview, I questioned each student about the recorded incidence of language switching (if any). The Persian and English language comprehension tests were administered to all four students in the RMIT library, on the same day.

3.2.3 Instruments

Semi-structured interview

A semi-structured, individual interview was conducted to explore the use of the Persian language in mathematical problem solving. For the purpose of this study, it was considered that ten mathematics items were sufficient. I needed enough questions to test across the range of different types of problems, but not so many that the students could not complete the questions in a reasonable time. The interview incorporated ten mathematics problems selected from Appendix A as appropriate together with a LS Checklist, and included a number of questions about the problem solving process, language switching events, and students’ background (see Appendix B). Each of these components is explained below.

The mathematics questions were derived from the ACER (PAT Maths) test (Australian Council for Educational Research, 2005) and included four symbolic, five word problems, and one open ended question appropriate to the age and year level of the students concerned. Each correct item was assigned a score of one. Symbolic questions involved four basic
arithmetic operations. Word problems involved some aspects of number (one or more operations required), and a variety of problem contexts including measurement and spatial topics. The open-ended question was an item, which had more than one answer. An example of each type of mathematics questions is given below.

Symbolic: 36 x 16

Word problem: Anna weighed her dog last week. He weighed 27.9 kg. This week he weighed 28.2 kg. How many grams had he put on?

Open-ended: Half of the people in a family are males. Could you draw a picture of what this family might look like?

In order to record the language(s) used when solving mathematical problems, a LS Checklist, which included two-columns for each question was used (see Table 3.1). At the completion of each mathematics question, students were asked to tick the box that best represented their use of language(s) for each question, where the “English language” column indicates use of L2 only, and the “Persian and English languages (L1 and L2)” column indicates the use of the Persian language (L1) for at least one part of a question. Ticks (√) were used to indicate language(s) used.

Therefore, by the end of each session the student had solved the mathematics problems and documented the language(s) used to perform each mathematical task. In this way, when I investigated the reasons for the student’s choices the student would not be influenced by matching his/her answer to the language choice of the interviewer. If these two were completed separately, as in the Clarkson study, it is possible that the L2 choice of the interviewer could cause language interference for the student, thereby skewing student choices of L2 over the L1.

Table 3.1: Example of partially completed Language Switching Checklist

<table>
<thead>
<tr>
<th>Question</th>
<th>English Language only</th>
<th>Persian and English Languages (L1 and L2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>2</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>√</td>
<td></td>
</tr>
</tbody>
</table>
At the end of the mathematics questions, I interviewed the students in English. First, I asked about the problem solving process, their language switching (if any), and what prompted them to use the Persian language. Then, a series of questions regarding students’ use of languages, their details and background were asked. These questions included:

- Do you use Persian language when you do mathematics homework?
- Do you use Persian language when do you mathematics in the classroom?
- What are the language(s) spoken at home?

(These questions are included in Appendix B).

Language comprehension tests
Cummins (1979) suggested that the level of understanding of the deep structure of a language could be examined by a comprehension test as opposed to vocabulary tests that relate to the surface structure of a language. Therefore, for the purpose of this study, I used the Persian and English comprehension-reading tests described below.

In order to investigate students’ English proficiency, I chose an English language comprehension test, TORCH test (Test of Reading Comprehension). This test is involved a narrative style reading text drawn from ACER (Mossenson et al., 2005) with 20 omitted words with a maximum raw score of 20. Five different TORCH tests were available for students in Years 3 and 4. At first, an average level test was selected (chosen) and administered. If a student’s response to the test was near zero or near perfect, the test was unable to distinguish the students’ comprehension level (Mossenson et al., 2005). In this case another easier or more difficult TORCH test was chosen and administered (see an example in Appendix C).

In order to determine the level of Persian language comprehension, I chose a Cloze language test derived from a Persian textbook (Iran Ministry of Education and Training, 2005) to identify students’ language proficiency in Persian (Farsi). This test consisted of a narrative style reading text with ten omitted words and with a maximum raw score of 10 (A copy of this Persian test is included in Appendix D).

3.2.4 Analysis of data
To find any particular pattern in relation to the language switching, mathematics competency and language proficiency, all the data from the language comprehension tests and interviews were analysed. In the first instance, students’ responses to the language tests and mathematics
questions were scored and collated. The level of student competency in mathematics as well as their proficiency in languages were then categorised into two levels, high and low. All student interviews were transcribed and the incidence of language switching (if any) noted. Analysis of the data derived from each instrument is described in more detail below.

Analysis of the English language test
In accordance with the TORCH guidelines (Mossenson et al., 2005) since the results of students would not be comparable for raw scores by using different TORCH tests, the raw scores were converted into a scaled score called a “Stanine”. With these scores, results can be compared for students irrespective of which TORCH test was completed. The Stanine score consists of nine different levels (Mossenson et al., 2005), starting from 1 (the worst) to 9 (the best). In order to compare the level of students’ proficiency in the English language, and based on the students scores, proficiency in English language was categorised into two levels, high and low (levels). For the purposes here, a Stanine score of 6 or more was considered to represent a “high” level of competency, and a score of less than 6 was considered to represent a “low” level of proficiency in the English language.

Analysis of the Persian language test
In the absence of standard Persian language comprehension tests, the raw scores (out of a maximal possible 10) of selected Persian cloze test were considered. In order to compare the level of students’ proficiency in the Persian language, students were categorised into two groups based on their scores on the Persian language test. The scores, which were equal to, or higher than the average score (5), were considered to be a “high” level of Persian language proficiency. Scores less than 5 were assumed to indicate a “low” level of proficiency in the Persian language.

Analysis of interview transcripts, students’ work, and Language Switching Checklist
The data derived from these instruments were analysed in two parts. The first part included a scoring of the students' responses to the mathematics questions. Students' responses to each question were scored on a 0 or 1 basis, where 1 indicated a correct answer. In order to compare the level of students’ mathematics competency, the students' performances were simply categorised into high and low levels. A score of 5 or more out of a maximal possible 10 was considered as a “high” level of mathematics competency, while scores of less than 5 were considered to represent a “low” level of competency for the purpose of this exercise. In the second part, the incidence of language switching for each type of mathematics questions
was noted. Then, a search for possible patterns in relation to language switching, mathematics competency, and language proficiency was undertaken.

### 3.2.5 Pilot study review

The results from the analysis of data tabulated in terms of incidence of language switching (if any), students’ competency in mathematics, and their proficiency in Persian and English language (the results of collected data). These results for each of the four students involved in the pilot study are shown in Table 3.2. Students are identified by a two-letter code for example, SM. Their grade level is indicated by the numbers immediately followed the code for example, SM3.

#### Table 3.2: Summary of pilot study results (N=4)

<table>
<thead>
<tr>
<th>Name/Code</th>
<th>Level of English proficiency</th>
<th>Level of Persian proficiency</th>
<th>Level of Mathematics competency</th>
<th>Incidence of language switching</th>
</tr>
</thead>
<tbody>
<tr>
<td>SM3</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>3 (2 symbolic, 1 word problem)</td>
</tr>
<tr>
<td>SA3</td>
<td>High</td>
<td>Low</td>
<td>High</td>
<td>2 (symbolic)</td>
</tr>
<tr>
<td>SS4</td>
<td>Low</td>
<td>Low</td>
<td>Low</td>
<td>2 (symbolic)</td>
</tr>
<tr>
<td>HM4</td>
<td>Low</td>
<td>High</td>
<td>High</td>
<td>8 (3 symbolic and 5 word problems)</td>
</tr>
</tbody>
</table>

It can be seen from the data in Table 3.2 that all four students switched to Persian, in at least two questions. One student, who had come to Australia at the end of 2004, used Persian in seven mathematics questions. Two students used Persian when solving symbolic and word questions, while two students switched to Persian only in symbolic questions.

The results of the English language test showed that, three students had a low proficiency in the English language. Similarly, the results of the Persian language test revealed that three students had a low level of proficiency in the Persian language. This suggested that most of students had difficulty in comprehending both the English or Persian languages.

The results for the students’ level in mathematics competency showed that two students [SA3, HM4] had a high proficiency in one language that is, English or Persian, and a high level of competency in mathematics. While the other students [SM3, SS4], who were considered as having a low proficiency in both languages, exhibited a low level of competency in
mathematics. While this is far too small a sample from which to generalise, the results of the pilot study suggest that a high proficiency in at least one language (one dominant) may be related to mathematics performance, which is consistent with Cummins’ “threshold” hypothesis (1979) and Clarkson’s findings (1996).

By looking at the data derived from transcribed interviews, more information was achieved about the student’s ability to make a start, mathematics performance, and the extent of language switching (if any). Examples of summary observations are given in Table 3.3 below.

**Table 3.3: Descriptive information of mathematics tasks in the pilot study**

<table>
<thead>
<tr>
<th>Mathematics question</th>
<th>Student</th>
<th>Summary observation (Ability to make a start, Correct/ incorrect, Extent of LS)</th>
</tr>
</thead>
</table>
| 153+278 =            | SA3 and SS4 | SA3 – Able to make a start. Correct. No LS  
SS4 - Able to make a start. Correct. LS |
| 56-29 =             | SA3, SS4, and HM4 | SA3 – Able to make a start. Correct. LS  
SS4- Able to make a start. Correct. No LS  
HM4- Able to make a start. Correct. LS |
| 38 x 6 =            | SA3 and SS4 | SA3- Able to make a start. Incorrect. LS  
She said, “I can do times with 2 digit number”.  
SS4- Able to make a start. Incorrect. No LS |
| 428 ÷ 3 =           | SS4 and HM4 | SS4- He said, “It is a hard question”. Incorrect. LS  
HM4- He said “Can I solve it in a Persian way because my teacher taught me recently?” but he seemed stressed, so did not continue. LS |
| 15 people went to the dancing show last week. This week 18 people went to the dancing show. How many more people attended this week compared to last week? | SM3 and SA3 | SM3- unable to make a start. Incorrect. No LS  
SA3- Able to make a start. Correct. No LS. |
| Jane had 20 books. Her friend gave her 12 books. Now how many books she has got? | SM3 | Able to make a start. Correct. No LS. |
| It is 10:50am now. Anna’s birthday party will start at 12:45 pm. How many minutes does she have to wait? | SM3 | SM3- Able to make a start. Incorrect. LS.  
SS4- Able to make a start. Correct. No LS.  
SA3- Able to make a start. Incorrect. No LS.  
HM4- Able to make a start. Incorrect. LS |
| Half of the people in the family are male. What might a drawing of that family look like? | SM3 | SM3- Able to make a start. Incorrect. No LS.  
SS4- Able to make a start. Correct. No LS.  
SA3- Able to make a start. Correct. No LS. |
As can be seen, students’ ability to solve mathematics questions and their performance varied. Some students were unable to make a start in some questions. In such cases therefore, language switching was not explored (see for example, SM3 in word problem involving with subtraction, 18 - 15). While in others, ability to make a start appeared to prompt language switching. This suggests a possible relationship between the incidence of language switching and ability to make a start.

The results of the pilot study showed that language switching occurred in all four students and that all students provided some explanation for their language switching during the interview. More importantly, language switching occurred across the range of problems, supporting Clarkson’s (1996) findings. The data provided by the mathematics and language tests showed that these tests were discriminating, that is, this group of students showed different levels of language proficiency, as well as different levels of competency in mathematics.

Since the number of students was limited in this study, the results of language switching, the relationship between language proficiency and mathematics competency could not be extrapolated beyond providing a guide for the main study.

As there was no standardized Persian language comprehension test to provide a scaled score, I used the raw scores to categorise students’ performance. By observing students while they worked on the Persian comprehension test, and reviewing their answers, I noticed that this kind of comprehension test (Cloze format) may not be appropriate for the purpose of the main study. The teachers in the Persian language schools use narrative style texts followed by some short answer questions to determine the level of students’ Persian language comprehension. In discussing the results of the pilot study, they felt that the Cloze test format probably did not provide an accurate reflection of the students’ proficiency in Persian language.

3.2.6 Implications for the main study

Based on the results and review of the pilot study, the following decisions were made in relation to the conduct of the main study.

- Since the students’ ability to make a start and their responses to each mathematics question varied (Table 3.3), it was decided that a range of mathematics questions with different levels of difficulty (easy, average, hard) would be used in the main study. As a consequence, five word problems, five symbolic questions, and one that was open
ended were developed at each level of difficulty (refer to Appendix E). These are described in more detail in the next section (3.3).

- Simply classifying students' mathematics performance on the basis of correct or incorrect (C/ IC) did not provide sufficient information about their mathematics performance suggesting a more sophisticated means of discriminating was necessary. This scoring method was too narrow to accurately determine solving mathematical questions. Therefore, not only C/ IC was involved but also some indication (insight) was needed for the extent to which students solve mathematical problems. For the main study, it was decided to use, in addition to C/ IC, three categories of partially correct (PC 1, PC 2, PC 3). These are expanded in more detail in Table 3.4.

- In accordance with the Persian teachers’ comments, the Persian language comprehension test was replaced by a Persian text followed by a range of short answer comprehension questions relevant to that text. These are detailed in next section.

3.3 MAIN STUDY

Because there is no standard methodology for research studies, each study requires a unique approach related to its own relevant settings and objectives. Based on the results of the pilot study and according to the research aim, a “case study” approach also appeared most appropriate for the main study.

3.3.1 Participants

Sixteen Iranian NESB students who attend the Doncaster and Box Hill Persian Schools on Saturdays were involved in this study. These schools were chosen because they are the only Persian language schools in Victoria that teach the Persian (Farsi) language to Iranian NESB students. There was no training for other subjects including mathematics. Nine students were from the Doncaster school and seven students were from the Box Hill school. The students from the two Persian language schools comprised eleven Year 4 students (8 boys and 3 girls), and five Year 5 students (1 boy and 4 girls). Most of the students participating in this study began their schooling in Australia. As the students speak Persian at home and their parents are Iranian, they were regarded as bilingual for the purposes of this study, with Persian (Farsi) as their first language (L1) and English as their second language (L2).
3.3.2 Procedure

In accordance with the need to comply with the procedures governing the conduct of research in Australia, I completed an Ethics Form and sent it to the Design and Social Context Portfolio Human Research Ethics Sub-Committee at RMIT University to obtain ethics approval (Appendix F). After gaining this approval from RMIT University, further ethics approval was sought and obtained from the Human Research Ethics Committee of the Victorian Department of Education and Training, Melbourne (Appendix G).

After gaining both ethics approvals, I approached the Principals of both Persian schools and obtained their permission to conduct this study in their schools.

Prior to the commencement of the study, since there were a limited number of Iranian NESB students who attend these schools, all of the students in Years 4 and 5 were invited to participate in this study by means of an invitation letter, which included the Plain Language Statement (Appendix H). The Plain Language Statement explaining the study was mailed to parents’ addresses. In accordance with the RMIT Ethics Guidelines, I assured the parents, that the confidentiality and anonymity of all participants’ details would be maintained. It was explained that participants also have the right to withdraw if they feel that the issues raised made them uncomfortable.

Parents were also required to sign a Consent Form (Appendix I) to allow their child to participate in the study. Before sending the above-mentioned letter, I had an informal meeting with the students’ parents and explained the details of the study in the Persian language. During the informal meeting, parents were told that the outcomes of this study may provide useful insights into Persian language teaching as well as mathematical problem solving by NESB students. Since parents were sensitive regarding some private issues such as family background and their present circumstances, I reassured them that the collected data of this study would not be disclosed to identify them or their child in any way, as all students names would be coded and not identified. A stamped envelope was provided for parents/guardians to return the signed Consent Form.

At the first session at both schools, parent questionnaires were administered to those parents/guardians who had signed the Consent Forms. The completed questionnaires were returned the following week through the students. I then arranged a suitable time with the Principals and Years 4 and 5 teachers in both schools to conduct the interview schedule and the English
and Persian language comprehension tests. Prior to carrying out the interview, and the English and Persian language tests, I explained the requirements of each procedure to the students.

Since a small number of Iranian NESB students were involved, at each school, the language comprehension tests were completed in class groups on consecutive Saturdays. However, the mathematics tasks and the associated LS Checklist were completed individually in order to record the extent to which L1 or L2 was used in the process of solving mathematical problems. For the purpose of this study, ten mathematics questions were administered on average to each student. Each question was written in English and prepared on a card. The pilot study showed that some students experienced difficulty in making a start on each question. Therefore, in the first instance I administered a question of average difficulty level. If the student was not familiar with the question or unable to make a start, I swapped the card for an easier question. If it appeared that the question was too easy, I used a more difficult one (the same type) for the next question.

After finishing the last (tenth) mathematics question, I engaged each student in a discussion about his/her mathematical problem solving, what prompted the use of the Persian language (language switching, if any), and home background. All student interviews were tape-recorded. During the interview, I noted any significant point such as the student’s reactions, and general approach. Ten students were interviewed at school. However, due to some limitations of time and available space, I interviewed six students in their homes.

3.3.3 Instruments

In order to address the research questions in this study, a parent questionnaire, two language tests, and an individual interview were used. These are described below.

Parents’ questionnaire

Parents’ views and home background features have been found to be important in this type of study (Clarkson and Dawe, 1994) and may have some impact on the mathematics performance of bilingual students. Clarkson and Dawe's survey (1994, 1996) explored an extensive range of background features. For this study, those specifically relating to the parental attitudes toward education and home status were selected. For instance, the parents’ questionnaire contained items regarding home status and background, such as parents’ expectation for their children's education; level of parental encouragement; duration of living in Australia; any history of attending childcare and/or kindergarten by their children in
Australia; the language spoken most of the time at home and language(s) used if parents or a tutor assisted the students with school assignments (see Appendix J).

Language comprehension tests
As a result of the pilot study, language comprehension-reading tests were used to explore the level of students’ proficiency in English and Persian.

- English language comprehension test:
  To investigate the level of English proficiency, five TORCH tests appropriate for Years 4 and 5 (Mossenson et al., 2005) were chosen. The procedure for administering and scoring this test was described in the pilot study (see 3.2.4). No changes were necessary for the main study (refer to Appendices C, K).

- Persian language comprehension test:
  In order to explore the level of students’ proficiency in the Persian language, a Persian language comprehension test was used. In the absence of a standardized Persian language comprehension test, the teachers in the Persian language schools in Victoria suggested a short answer question format. The teachers identified five tests at different levels of difficulty and indicated which test would be most appropriate for each child. At first, I administered an average level test. If the student was unable to make a start, I swapped it for an easier test. If it seemed too easy, I used a more difficult test (refer to Appendix L).

Interview
I used a semi-structured, individual interview to explore the use of the Persian language (if any), and reasons why students switched languages when attempting to solve mathematics problems. The interview comprised two phases: the mathematics questions associated with a LS Checklist (to record any language switching while solving a problem) followed by a series of questions about the student’s problem solving strategies, their use of language switching, and home background. These aspects are described below.

- Mathematics questions
  In order to explore the level of students’ competency in mathematics and investigate the incidence of language switching when NESB students are solving mathematical problems, ten mathematics questions were administered to each student.
Thirty-three mathematics questions from ACER (PAT Maths) (2005) (refer to Appendix E) including symbolic, word problem, and open-ended questions, were used for the main study. Five symbolic questions, five word problems, and one open ended question were provided at each level of difficulty, that is, a high, average, and low level (see Appendix E). These are detailed below.

a) Symbolic questions: These items were either presented as (horizontal) equations or in vertical algorithms. Addition, subtraction, multiplication, and division questions were used, together with a multi-step problem that involved a combination of operations. For example, three multiplication items, one at each level of difficulty, are presented below.

- Easy symbolic question: 14 x 5
- Average symbolic question: 38 x 6
- Hard symbolic question: 36 x 16

b) Word Problems: As explained in pilot study (3.2.3), most of the word problems involved measurement or spatial contexts. As an example, three subtraction problems, one at each level of difficulty, are presented below.

- Easy word problem: After 12 games of basketball Ali had scored 38 goals. Amir had scored 56 goals. How many more goals did Amir score than Ali?
- Average word problem: Anna’s birthday party will start at 12:45 pm. It is 10:50 am now. How much longer does she have to wait?
- Hard word problem: 436 people went to the soccer match last week. This week 508 people went to the match. How many 7 more people went to the soccer match this week than last week?

c) Open-ended questions: These questions are open-ended in the sense that they may have more than one correct answer. In this study, one open-ended question was
developed for each level of difficulty (easy, average, hard). To provide an example, three open-ended problems, one at each level of difficulty, are presented below.

Easy open-ended: Zari has 10 pens. She wants to give some pens to her brother. How many pens does her brother receive?

Average open-ended: Chocolate bars cost $2.50 each. Muesli bars cost $1.50 each. Ali had $50. He bought 4 chocolate bars and some muesli bars. How much money did he have left?

Hard open-ended: Half of the people in a family are males. Could you draw a picture of what this family might look like?

While 33 mathematics questions were prepared on individual cards, only twenty questions were actually used in this study. As previously explained, ten questions were administered to each student. Since students’ ability to make a start varied, I began with an average level question. If the student was unable to make a start, I swapped the card for an easier question. If it appeared that the question was too easy, I used a more difficult one for the following question. While the students solved the mathematics problems I carefully observed their reactions and noted any significant points.

- Language Switching Checklist
  The LS Checklist illustrated in Table 3.1 was completed by each student as he/she solved each problem. Details were described in the pilot study. No changes were necessary for the main study.

- Interview questions
  Based on the completed LS Checklist and students working, the students were interviewed individually. Immediately following the completion of mathematics questions, I engaged the student in a discussion about his or her problem solving and language switching. Examples of questions discussed are given below.

  - How did you answer the question? (What did you do first? etc)
  - What language did you use to begin to solve the problem?
- Did you switch between languages? At which stage?
- If you used the Persian language for doing the mathematics questions, why?
- If you used the English language for doing the mathematics questions, why?
- Is there any word/ statement that would be difficult to translate directly into Persian (Farsi)?

Then, background details including age, gender, and birthplace, and also the use of Persian language (when, where), were noted (Appendix M). All students’ interviews were transcribed for further analyses.

3.3.4 Initial Analysis

In order to explore the role of language switching for these bilingual students when solving mathematical problems, as well as the responses to the other research questions, the data derived from the instruments were analysed. These data were concerned with; incidence of language switching, students’ reasons for language switching, students’ proficiency in the English and Persian languages, students’ competency in mathematics, students' background and parents’ views. This section will describe how the data derived from each instrument were analysed.

Analysis of parents’ questionnaire

Data regarding student details and use of L1/L2 at home, at mealtimes, during family discussions, and during any assistance with mathematics homework or assignments were collated. Parents’ attitudes toward their children education, and level of parents’ encouragement were also noted.

Analysis of the English language test

As previously explained in the pilot study (refer to section 3.2.4), English language proficiency was analysed according to the TORCH guidelines (Mossenson et al., 2005). For the purposes here, a 'Stanine' score of 6 or more was considered to represent a “high” level of competency and a score of less than 6 was considered to indicate a low level of competency in English.

Analysis of the Persian language test

The Persian language test results were discussed with the relevant Persian teacher in order to classify the students’ level of Persian language proficiency. For example, students who were
unable to provide a correct or reasonable response to questions and exhibited a low performance in class activities in the Persian school, were considered as having a “low” level of proficiency in Persian. But students, who were able to display correct comprehension of the text, as well as exhibiting a high level of performance in class activities in the Persian school, were considered to be at a “high” level of proficiency in the Persian language.

Analysis of interview transcripts

The data comprising the transcripts of interviews, student records, and the LS Checklist, were analysed in four steps which are detailed below.

Step 1- This step involved scoring the students’ responses to each question and assigning an overall category to indicate students’ competency levels in mathematics.

The students’ answers to each mathematics item were scored according to one of five scoring rubrics, that is, incorrect (IC); partially correct which includes PC1, PC2, PC3; and correct (C). These are described below and illustrated using a range of responses to the word problem:

Eight families shared a prize of $780. How much did each family receive? (Table 3.4)

Table 3.4: Description of five different levels of scoring with an example of an answer to the above question

<table>
<thead>
<tr>
<th>Scoring Code</th>
<th>Description</th>
</tr>
</thead>
</table>
| Incorrect (IC)        | Incorrect, does not recognise operation(s) required, no response, working or explanation.  
  Eg (by SZ4): \[780 + 8\] \[\frac{8}{8}\] = 1668 |
| Partially correct (PC1) | Incorrect, recognises the operation(s) required, unable to apply appropriate procedure or strategy, little or no working.  
  Eg (by AN4): \[780 : 8\] |
| Partially correct (PC2) | Incorrect, recognises the operation(s) required, makes a start, but generally unable to complete procedure or perform strategy, some working and/or explanation may be provided.  
  Eg (by AS4): \[8 \times 780 \div 6\] |
Table 3.5: Three different levels of students' mathematics competency

<table>
<thead>
<tr>
<th>Mathematics Competency</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>Able to solve most mathematics questions correctly at a level of difficulty appropriate to their age/Year level</td>
</tr>
<tr>
<td>Average</td>
<td>Generally makes a start on average or hard questions but unable to answer correctly, able to solve easy questions most of the time</td>
</tr>
<tr>
<td>Low</td>
<td>Experiences difficulty making a start or solving most questions, even those that are relatively easy.</td>
</tr>
</tbody>
</table>

For example, AS4 was categorised as being at an "average level" of competency in mathematics, as he was able to recognise the correct algorithm when solving an average word problem involving division. While he was unable to solve this problem completely, he was able to solve the easy symbolic question involving addition or subtraction algorithms correctly and quickly.
Step 2 – This step involved annotating the transcripts to identify evidence of language switching (LS) and the possible prompts. A “comments” column was added to the transcripts for this purpose. Student codes were used to indicate student responses. The interviewer is referred to as “Int.”.

In this step, I was interested in finding any evidence of language switching, as it occurred and possible prompts for language switching. For this purpose, each interview transcript was carefully read, and re-read and annotated as appropriate. An excerpt from a transcribed interview of a student (AS4) shown in Table 3.6, was for solving an average word problem, involving division

Eight families shared a prize of $780. How much did each family receive?

This analysis is illustrated in the “Comments column”.

**Table 3.6: An example of a transcribed interview**

<table>
<thead>
<tr>
<th>NAME: AS4</th>
<th>Date: 25.11.2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment: Doncaster Language School</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Who</th>
<th>What was said (transcript)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Int.</td>
<td>What about question six? You also switched. It’s very interesting that you know for this question, this question is about family and you know you have to use…division and just doing division is hard for you. Yes?</td>
<td>difficulty</td>
</tr>
<tr>
<td>AS4</td>
<td>Yes, I found difficulty with division.</td>
<td></td>
</tr>
<tr>
<td>Int.</td>
<td>Division difficulties?</td>
<td></td>
</tr>
<tr>
<td>AS4</td>
<td>I found division hard.</td>
<td></td>
</tr>
<tr>
<td>Int.</td>
<td>Ah… If I change to two digits maybe is easier then?</td>
<td></td>
</tr>
<tr>
<td>AS4</td>
<td>Maybe</td>
<td></td>
</tr>
<tr>
<td>Int.</td>
<td>Yes, Did you switch in Persian? If it was 2 digits, instead of seven hundreds eighty, if it was seventy-eight did you use Persian or no?</td>
<td></td>
</tr>
<tr>
<td>AS4</td>
<td>Yes, yes.</td>
<td></td>
</tr>
<tr>
<td>Int.</td>
<td>At which stage did you use Persian?</td>
<td></td>
</tr>
<tr>
<td>AS4</td>
<td>Well in this bit I’ve got confused. Well after eight divided by seventy to which there is nine remainder six and I put six into sixty and I’ve got confused, because I know nothing times… eight, sixty… so I transferred to Persian.</td>
<td>LS (when confused)</td>
</tr>
</tbody>
</table>
Step 3 – This step involved recording students’ language switching and level of mathematics performance for each problem.

This step involved two parts: analysis of language switching, and analysis of mathematics performance. For the first part, transcript evidence of language switching and the LS Checklist were matched to confirm where language switching occurred. For each mathematics question, all information about students’ language switching (LS) or not (NLS), and their reason for using the Persian language (L1) was noted for further analysis.

In the second part, for each problem student’s mathematics performance on each question were scored in terms of IC, PC1, PC2, PC3, or C (see Table 3.4), and where possible the student’s strategies for solving mathematical problem were noted and examined. This analysis is illustrated in Table 3.7 for two students (LA5 and ML4) in relation to the following problem, where LS refers to evidence of language switching.

436 people went to the soccer match last week. This week 508 people went to the match. How many more people went to the soccer match this week than last week?

Table 3.7: A part of the third step of initial analysis for a mathematics question of two students

<table>
<thead>
<tr>
<th></th>
<th>LA5</th>
<th>ML4</th>
</tr>
</thead>
<tbody>
<tr>
<td>LS: “I did the first column in English but the rest I said in my mind in Persian but I did write it down in English”</td>
<td>LS: “for the last step of the answer used Farsi”</td>
<td></td>
</tr>
<tr>
<td>When prompted (could you please give an example?) She said” panjah menhayeh chehel-o- shesh (50 - 46 in Persian). Dah menhayeh seh (10 – 3 in persian) chand mishe (how many is it? in Persian)”</td>
<td>Comments: It appears she used Persian when she had difficulty implementing subtraction algorithm.</td>
<td></td>
</tr>
<tr>
<td>When she was prompted (was any English word used in this question), She said, “Yes, here on the first column …because it was really simple, quick to write it down that number and I don’t need to think much about it”</td>
<td>She added 508 and 436 and got 934.</td>
<td></td>
</tr>
<tr>
<td>Comments: It appears, she used Persian in the part which needed more thinking.</td>
<td>When she was asked (why didn’t you use another algorithm like, times or take away? ), she said” Because if you use take away, it doesn’t help that…Because it says how many more came”.</td>
<td></td>
</tr>
<tr>
<td>Her answer was 72. She used subtraction (508 -436) vertically and got the correct answer.</td>
<td>Comment: It appears she solved this question completely incorrectly, however she was confident in choosing addition to solve the problem.</td>
<td></td>
</tr>
<tr>
<td>Comment: It appears she was able to do take away.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3.3.5 Comparative Analysis

In order to address to the second, third, and fourth research questions of this study, the summative data derived from the initial analysis were compared/contrasted across different categories. The comparative analysis involved two steps. In the first step, data pertaining to each mathematics question were collated. In this case, the number of attempts, the distribution of scores (IC, PC1, PC2, PC3, and C), and the frequency of language switching were compared. In the second step, all data pertaining to each student were collated. These two steps are explained in more detail below.

Step 1 – This step involved looking for patterns of language switching in relation to mathematics performance and type of question.

Summative data of language switching and mathematics performance were tabulated by question in order to looking for patterns or relationships between language switching (LS, NLS) and mathematics performance on each question (IC, PC1, PC2, PC3, C); language switching and type of mathematical problem (open-ended, word problem, or symbolic question); and between mathematics performance and type of question. These patterns were identified by examining similarities and differences in the students’ responses to each type of question. A sample of this data is shown in Table 3.8.

Table 3.8, shows an example of how the summative data was collated for one word problem and a symbolic question, where LS indicates language switching, C indicates a correct answer, PC (1,2,3) indicates a partially correct answer, and IC indicates an incorrect answer.

<table>
<thead>
<tr>
<th>Math questions (answer)</th>
<th>Total number of attempts</th>
<th>Distribution of Scores</th>
<th>Frequency of (LS)</th>
</tr>
</thead>
</table>
| 436 people went to the soccer match last week. This week 508 people went to the match. How many more people went to the soccer match this week than last week? (72) | 11 | C= 9  
PC (1)= 1  
PC (2)= 0  
PC (3)= 0  
IC= 1 | 4 |
| 76 –39 (37) | 6 | C= 6  
PC (1)= 0  
PC (2)= 0  
PC (3)= 0  
IC=0 | 3 |
This table shows that a hard word problem involving subtraction was attempted eleven times and solved correctly nine times, once partially correctly, and once incorrectly. Four students switched to the Persian language when solving this question. By comparing this type of data across the different types of questions, differences as well as similarities could be found.

Step 2- This step involved looking for patterns of language switching in relation to the data derived from all the instruments.

For the purpose of this study, I was looking for patterns and relationships between all elements of data, such as between language switching and type of question, between language switching and item difficulty, and between language proficiency and mathematics competency. These patterns were identified by examining similarities and differences in the data.

To illustrate this step of the comparative analysis, the summative data for the two students, AN4 and NM4, is shown in Table 3.9. These data are the mathematic performance, the frequency of language switching for each type of questions, where language switching occurred, as well as proficiency in the both English and Persian languages.

**Table 3.9: An example of the second step of the comparative analysis for two students**

<table>
<thead>
<tr>
<th></th>
<th>AN4</th>
<th>LA5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mathematics</strong></td>
<td>1 open ended (drawing): PC (3)</td>
<td>1 open ended: C</td>
</tr>
<tr>
<td></td>
<td>Word problems:</td>
<td>Word problems:</td>
</tr>
<tr>
<td></td>
<td>Division (3 digits ÷ 1 digit): PC (2)</td>
<td>Division (3 and 1 digit): PC(3)</td>
</tr>
<tr>
<td></td>
<td>Time (Anna task): PC (2)</td>
<td>Time (Anna task): C</td>
</tr>
<tr>
<td></td>
<td>Multiplication (2 digits x 1 digit): PC (2)</td>
<td>Multiplication (1x2 digit): C</td>
</tr>
<tr>
<td></td>
<td>Addition (2 digits + 2 digits): C</td>
<td>Subtraction (3-3 digit): C</td>
</tr>
<tr>
<td></td>
<td>3 steps (2 Multiplication and 1 Addition): C</td>
<td>Addition (2+2 digit): C</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td>2 steps (Addition and Division):C</td>
</tr>
<tr>
<td></td>
<td>Symbolic:</td>
<td>Symbolic:</td>
</tr>
<tr>
<td></td>
<td>Multiplication (2 digits x 1 digit): PC (3)</td>
<td>Multiplication (2x1 digit): C</td>
</tr>
<tr>
<td></td>
<td>Subtraction (3 digits - 2 digits): PC (3)</td>
<td>Subtraction (3digit- 2 digit): C</td>
</tr>
<tr>
<td></td>
<td>Division (2 digits ÷ 1 digit): C</td>
<td>2 steps (Division and Subtraction): C</td>
</tr>
<tr>
<td></td>
<td>2 steps (Multiplication and Addition): C</td>
<td></td>
</tr>
<tr>
<td><strong>Attempted questions</strong></td>
<td>10 (4 symbolic, 5 word, 1 open ended)</td>
<td>10  (3symbolic, 6 word, 1 open ended)</td>
</tr>
<tr>
<td><strong>LS (type of</strong></td>
<td>In 3 questions (2 symbolic, 1 word)</td>
<td>In 2 questions (1symbolic, 1 word problem)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 3.9 is an example of how the analysis was conducted across all sixteen students. In this case, the table summarizes the data related to two students, AN4 and LA5. AN4, who was considered to be of low proficiency in both languages and have low competency in mathematics, used language switching in three questions (one word problem and two symbolic). He switched to the Persian language to read the number 3 and 9 when solving a symbolic question. However, LA5 switched in 2 questions (one word problem and one symbolic question). She had a high competency in mathematics. She used the Persian language to write and read the numbers 3 and 9. This suggests, there was a similarity between these two students for language switching, as both student switched in a subtraction question. There was also a difference between their levels of competency in mathematics. The possible patterns were identified, by examining similarities and differences in this manner.

3.4 SUMMARY

Based on the aims of this study and in order to explore the research questions, it was decided to use a case study approach for the Iranian NESB students incorporating an interview schedule, two language comprehension tests, and a parents’ questionnaire.

A semi-structured interview was conducted for each student, and tape-recorded for future reference. At the beginning of the interview ten mathematics questions were delivered one-by-one on consecutive cards, and simultaneously the students recorded the language(s) used
on a LS Checklist. On the completion of the last question, I engaged each student in a discussion about the incidence of and reasons for language switching (if any) for each question. Interviews were then transcribed and considered with the results of the language tests and mathematics questions to address the research questions.

Data processing involved two main forms of analyses, initial and comparative. In the initial analysis the data derived from all the instruments were tabulated. In the comparative analysis, I was looking for patterns of language switching in relation to mathematics performance as well as in relation to three types of mathematics questions. I was also looking (examining the data) for any patterns in relation to mathematics performance and the type of mathematics problem. In the second step I was looking for patterns or relationships between all elements of data, such as LS and question difficulty, languages proficiency, and demographic data.

The results of these analyses on the data obtained from the sixteen Iranian NESB students are presented in the next chapter.
CHAPTER 4 — RESULTS

The aim of this study was to investigate language switching (LS) in a group of Iranian non-English speaking background (NESB), Year 4/5 students in Melbourne, Victoria, as they solved a range of mathematics problems.

As previously explained in Chapter 3, in order to address the research questions for this study, a semi-structured interview, language comprehension tests, and a parent questionnaire were used to gather and collate data. The interview questions consisted of ten mathematics questions from the Australian Council of Educational Research (ACER, 2005) accompanied by a language switching Checklist (LS Checklist) for recording the languages used when solving each problem. It also included questions about the student’s strategy for solving individual questions and the reasons for language switching where relevant. In addition, there were questions about the student’s background. In terms of the language tests, the Persian language test was selected from a Persian textbook. The TORCH Test (Mossenson et al., 2005) was selected to explore student’s competency in the English language. The questionnaire to which the parents responded sought information on their views and attitudes towards the use of language within school mathematics, and also on their children’s backgrounds.

The data derived from all the instruments were analysed through two consecutive analyses: the Initial and Comparative. These analyses are detailed more below.

In the Initial Analysis, the students’ answers to the mathematics questions and languages tests were assessed and noted. On this basis, the level of students’ mathematics competency were determined according to a high, average, low basis. The levels of students’ proficiency in the Persian and English language were categorized into two levels: high and low. In the first step of interview analysis, language switching (if any) and possible prompt(s) of language switching were recorded on the transcription of the interviews. In the second step, data about language switching and mathematics performance were noted for each attempted question. These were; the language(s) used for solving, student’s mathematics performances, explanation (reasons) for language switching, and student’s strategies for solving that question (if provided).
The first step in the Comparative Analysis involved looking for patterns of LS in relation to mathematics performance (IC, PC1, PC2, PC3, C) and type of mathematics questions (easy, average, and hard). The relationship between mathematics performance and the type of question was also examined. The second step involved looking for patterns or relationships between all elements of the data, such as the relationship between language switching and item difficulty; language switching and languages proficiency; language switching and students’ background; language switching and the physical environment; and mathematics competency and language(s) proficiency. The possible patterns were identified, by examining similarities and differences in the data.

The focus of this chapter is on reporting data derived from the initial analysis and the patterns and relationships derived from the comparative analysis. The data obtained from sixteen students will be reported in four sections. Summative data that relates to the demographic information derived from the parents’ questionnaire, language proficiency, and mathematics competency will be presented in section 4.1. The incidence of language switching, that is, overall reporting of language switching that occurred across students as well as type of question are reported in section 4.2. In section 4.3 the reasons for language switching are presented, base on the analyses of students’ interview data. These reasons were difficulty with problem interpreting and/ or difficulty with implementing particular algorithms, familiarity with particular numbers used habitually (in Persian), and environmental effects. The relationships between mathematics competency and language proficiency, between mathematics competency and gender, and between students’ backgrounds and language switching, will be reported in section 4.4. Finally, a summary of findings will be briefly presented.

4.1 SUMMATIVE DATA

Data from the parents’ questionnaire and students’ responses to the language tests and mathematics questions were explored through the initial analysis. This data has been organised into three sections, demographic information, that is, information about the relative use of the Persian or English language(s) in different out-of-class activities, and parents’ views about the educational expectations for their children and common language(s) spoken in the home (section 4.1.1); language proficiency in English and Persian, (high, or low level) (section 4.1.2), and mathematical performance/ competency, (high, average, or low level) (section 4.1.3). These results are described in more detail below.
4.1.1 Demographic information

Data from the parents’ questionnaires on the use of language(s) in different activities and their views are summarized in Tables 4.1, and 4.2 below.

Table 4.1: The frequency of languages used during daily activities or different situations (N=16)

<table>
<thead>
<tr>
<th>Activity (Situation)</th>
<th>Persian</th>
<th>English</th>
<th>Mixed</th>
<th>Not provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>On arrival to Australia</td>
<td>14</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>At home</td>
<td>14</td>
<td>1</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>At mealtime</td>
<td>12</td>
<td>-</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>In family discussion</td>
<td>10</td>
<td>1</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>Preference for speaking</td>
<td>14</td>
<td>-</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>In helping with Math. assignments</td>
<td>1</td>
<td>4</td>
<td>8</td>
<td>3</td>
</tr>
</tbody>
</table>

Most parents spoke Persian as their main language when they came to Australia. Except for the family with the Chinese mother [NM4], all parents used the Persian language when speaking with their children at home. However, both the English and Persian languages were used for discussion at home by four families [RK5, SH4, NM5, NK5]. A high proportion of families preferred to use and speak the Persian language as their main language when they came to Australia, suggesting a possible enthusiasm of this group to maintain the Persian language.

A group of parents [RK5, AZ4, AY4, SR5, AS4, NM5, SH4, NM4] (n=8) used both Persian and English when helping their children in mathematics homework. Another group [PA4, NK5, AN4, MH4] (n=4) used only English when helping their children. Two parents [SZ4, BL4] reported that they rarely helped their children in this regard.
Parents’ attitudes in relation to assisting their children to achieve high academic achievement, or to use Persian as opposed to English at home, and when their children solved mathematical problems, are summarized in Table 4.2. In this table, positive and negative views indicate parents’ agreement or disagreement with each situation.

**Table 4.2: Parents’ views regarding education and their encouragement**

<table>
<thead>
<tr>
<th>Situation</th>
<th>Yes (positive)</th>
<th>No (negative)</th>
<th>Not important</th>
<th>Not provided</th>
</tr>
</thead>
<tbody>
<tr>
<td>High educational expectation</td>
<td>11</td>
<td>-</td>
<td>-</td>
<td>5</td>
</tr>
<tr>
<td>Using Persian language at home</td>
<td>12</td>
<td>2</td>
<td>-</td>
<td>2</td>
</tr>
<tr>
<td>Using Persian language for mathematics problem solving</td>
<td>2</td>
<td>11</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

It can be seen that most parents had a positive attitude towards education and strongly believed that a high level of educational performance by their children would provide the success needed for their future lives. They demonstrated this attitude by: explaining how educational progress could affect their children’s futures; providing extra sources of educational materials; supporting the student or sending the student to a private school or providing a tutor [comments from the parents’ questionnaires]. It suggests that Iranian families in this study were concerned about their children’s future and supported them to achieve a high educational level.

Although four parents used L2 for helping their children when solving mathematical problems (see Table 4.1), eleven parents did not encourage their children to use L1 while solving problems. This is possibly because they believed that this might confuse their children in problem solving, hence affecting children’s mathematical achievement.

### 4.1.2 Language proficiency

According to the results of the English language test (TORCH), 7 students (44 %) were considered highly competent in English, and 9 students (56 %) were considered to have a low level of competency in English.
The result of the Persian language comprehension test showed that 6 students (37.5 %) scored at a high level of proficiency, and 10 students (62.5 %) showed a low level of proficiency.

Students who had a relatively high proficiency in both their languages were identified, as were students who had a relatively low proficiency in both their languages. Students who had high proficiency in one of their languages were defined as *one dominant* students in accordance with Clarkson (1991, 1996). This information is shown in table 4.3.

**Table 4.3: Language proficiency in Iranian NESB students (N=16)**

<table>
<thead>
<tr>
<th>English</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Persian</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>8</td>
<td>2</td>
</tr>
<tr>
<td>High</td>
<td>1</td>
<td>5</td>
</tr>
</tbody>
</table>

It can be seen that eight students (50%) were considered to represent a low level of proficiency in both languages. Five students (31.3%) were classified as having a high level of proficiency in both languages.

As an example of the first category (low level in both languages) ML4 obtained a score of 2 out of 9 on the TORCH test, indicating a low level of English language proficiency. This student was also ranked as having low proficiency in the Persian language based on the result of the Persian language test.

On the contrary, BL4 scored 7 out of 9 on the TORCH test, indicating a high level of proficiency in this language. His Persian language test was assessed and classified as being at a high level.

Two students [LA5 and AZ4] were classified as ‘one dominant’. LA5 was considered to be at a high level of proficiency in English and low level of proficiency in the Persian language, while AZ4 was categorized as having a low level of proficiency in English and a high level in Persian language proficiency.
4.1.3 Mathematics performance

As explained in Chapter 3, on average ten mathematics questions were administered to each student during interviews. These varied according to type of questions (symbolic, word problem, or open-ended) and level of difficulty (easy, average, or hard). All the students’ responses were analysed (marked) in terms of the five scoring rubrics described in Table 3.4 (IC, PC1, PC2, PC3, C). As the number of each type of question varied, student scores are reported as a percentage of the number of questions attempted of each type in Table 4.4.

Table 4.4: Proportion of the scoring of responses across the three types of question attempted

<table>
<thead>
<tr>
<th>Questions</th>
<th>Attempted</th>
<th>IC (%)</th>
<th>PC1 (%)</th>
<th>PC2 (%)</th>
<th>PC3 (%)</th>
<th>C (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Open-ended</td>
<td>16</td>
<td>3 (18.8%)</td>
<td>1 (6.2%)</td>
<td>–</td>
<td>1 (6.2%)</td>
<td>11 (68.8%)</td>
</tr>
<tr>
<td>Word problem</td>
<td>89</td>
<td>12 (13.5%)</td>
<td>15 (16.9%)</td>
<td>18 (20.2%)</td>
<td>5 (5.6%)</td>
<td>39 (43.8%)</td>
</tr>
<tr>
<td>Symbolic</td>
<td>58</td>
<td>5 (8.6%)</td>
<td>2 (3.5%)</td>
<td>3 (5.2%)</td>
<td>8 (13.8%)</td>
<td>40 (69%)</td>
</tr>
</tbody>
</table>

Most attempted questions were word problems, followed by symbolic questions, and the least attempted questions were open-ended.

Of the attempted questions, the symbolic and open-ended questions had the highest proportion of correct responses (69%). Word problems had the lowest proportion of correct answers (44%). This finding suggests that students had more difficulty when solving word problems compared to symbolic and open-ended questions.

As previously explained in Chapter 3, in order to compare students’ mathematics performances, their competency was classified into three levels: high, average, or low, based on the evaluation of their performance over all questions (refer to Table 3.5). The proportion of students in each category of mathematics competency is shown in Table 4.5.

Table 4.5: Classification of students’ mathematics competency (N=16)

<table>
<thead>
<tr>
<th>Mathematics competency level</th>
<th>High (%)</th>
<th>Average (%)</th>
<th>Low (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number (%) of students</td>
<td>7 (44%)</td>
<td>4 (25%)</td>
<td>5 (31%)</td>
</tr>
</tbody>
</table>

In terms of the criteria used for the purposes of this study, most students were considered to be at an average or high level of mathematics competency. Less than one-third of the students had a low competency in mathematics.
4.2 INCIDENCE OF LANGUAGE SWITCHING
As previously stated, all mathematics questions were administered in English. In this study, “language switching” is defined as using the Persian language (L1) for solving at least part of a question. The incidence of language switching can be viewed in terms of, the proportion of students who used language switching for different problem types, but it can also be viewed in terms of the number of language switching events as a proportion of the number of different questions attempted. These will be considered below in section 4.2.1 and 4.2.2 respectively.

4.2.1 Language switching events as a proportion of students who used L1
Overall, 14 students (87.5%) switched to Persian, while two students [BL4 and SR5] did not switch languages in any of the problems attempted. Based on data from the interview transcripts, all 14 students (87.5%) switched to the Persian language when solving word problems, while 10 students (62.5%) switched to L1 when solving symbolic questions, and four students (25%) switched to L1 to solve open-ended questions.

This finding showed that the highest incidence of language switching occurred in relation to word problems. This suggests a possible relationship between word problems and language switching. The least events of language switching occurred in relation to open-ended questions. This could be due to the limited number of open-ended questions attempted (only one question) by each student.

The frequency of students who switched to the Persian language across different levels of item difficulty (easy, average, hard) and problem type (open-ended, word problem, symbolic) is presented in Table 4.6.

<table>
<thead>
<tr>
<th>Question type</th>
<th>Open-ended</th>
<th>Word problem</th>
<th>Symbolic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Level of item difficulty</td>
<td>Average</td>
<td>Hard</td>
<td>Easy</td>
</tr>
<tr>
<td>Students who switched to L1</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
</tbody>
</table>

Overall, most students switched to L1 to solve hard word problems. It can be seen that for word problems, with an increase in item difficulty, there is an increase in the number of
students who switched to their L1, suggesting a possible relationship between language switching and item difficulty for this type of question. However, in open-ended and symbolic questions there is no specific trend between item difficulty and incidence of language switching.

4.2.2 Language switching events as a proportion of attempted questions
As indicated above, using L1 (the Persian language) for solving at least a part of each question was counted as one incidence of language switching. In focussing on the attempted questions rather than the number of students, the proportion of language switching was examined (investigated) across the three types of questions (symbolic, word problem, or open-ended). The results are presented in Tables 4.7.

Table 4.7: Proportion of language switching in the three types of question attempted

<table>
<thead>
<tr>
<th>Question type</th>
<th>Open-ended</th>
<th>Word problem</th>
<th>Symbolic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attempted</td>
<td>16</td>
<td>89</td>
<td>58</td>
</tr>
<tr>
<td>Proportion of</td>
<td>4</td>
<td>27</td>
<td>16</td>
</tr>
<tr>
<td>language switching</td>
<td>(25%)</td>
<td>(30.3%)</td>
<td>(27.6%)</td>
</tr>
</tbody>
</table>

This table shows that most language switching occurred in word problems followed by symbolic questions for this particular group of Iranian bilingual students. In order to investigate of the relationship (if any) between language switching and the level of item difficulty (easy, average, and hard), the proportion of language switching across different levels of item difficulty irrespective of problem type are detailed in Table 4.8 below.

Table 4.8: Proportion of language switching across different levels of item difficulty

<table>
<thead>
<tr>
<th>Item difficulty</th>
<th>Easy</th>
<th>Average</th>
<th>Hard</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attempted</td>
<td>31</td>
<td>60</td>
<td>72</td>
</tr>
<tr>
<td>Proportion of</td>
<td>8</td>
<td>19</td>
<td>21</td>
</tr>
<tr>
<td>language switching</td>
<td>(25.8%)</td>
<td>(31.7%)</td>
<td>(29.2%)</td>
</tr>
</tbody>
</table>

As can be seen, irrespective of problem type, the proportion of language switching for average and hard problems is similar and these appear to be more likely to lead to language switching than the easy questions. In some hard problems there was no language switching.
This may explain why the proportion of language switching in hard problems was less than that for average questions. Thus, the proportion of language switching across different levels of item difficulty may not be affected by difficulty level alone.

Although there are some differences in the proportion of language switching for different types of questions (see Table 4.7), it would appear that language switching mostly occurred in word problems and symbolic questions. It is not clear from these two tables (Tables 4.7 and 4.8) that item difficulty has a direct relation to the proportion of language switching, because these proportions are too similar. In order to provide a clearer picture of language switching, it is necessary to look into patterns of language switching in relation to item difficulty and (in) three types of question. In Table 4.9 the proportion of language switching across item difficulty and problem type is presented.

<table>
<thead>
<tr>
<th>Questions</th>
<th>Attempted</th>
<th>Proportion of LS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Open-ended</td>
<td>4</td>
<td>1 (25%)</td>
</tr>
<tr>
<td>Hard Open-ended</td>
<td>12</td>
<td>3 (25%)</td>
</tr>
<tr>
<td>Easy Word problem</td>
<td>12</td>
<td>2 (16.7%)</td>
</tr>
<tr>
<td>Average Word problem</td>
<td>35</td>
<td>11 (31.4%)</td>
</tr>
<tr>
<td>Hard Word problem</td>
<td>42</td>
<td>15 (35.7%)</td>
</tr>
<tr>
<td>Easy Symbolic</td>
<td>19</td>
<td>6 (31.6%)</td>
</tr>
<tr>
<td>Average Symbolic</td>
<td>21</td>
<td>7 (33.3%)</td>
</tr>
<tr>
<td>Hard Symbolic</td>
<td>18</td>
<td>3 (16.7%)</td>
</tr>
</tbody>
</table>

As opposed to the proportion of students who switched to L1 (Table 4.6), this table shows the proportion of language switching in attempted questions across the three levels of difficulty and problem type. It can be seen that the proportion of language switching increased with item difficulty when solving a word problem, while the incidence of language switching did not increase with item difficulty in symbolic and open-ended questions. Language switching occurred more frequently in hard word problems (35.7%) and average symbolic questions (33.3%). The least language-switching incidence was in easy word problems (16.7%) and hard symbolic questions (16.7%).
The proportion of language switching for word problems may suggest that difficulty understanding the context of the hard word problems caused an increase in the incidence of language switching. This trend was not similar for symbolic and open-ended questions.

4.3 REASONS FOR LANGUAGE SWITCHING
Based on the results of Table 4.4, it seems that word problems were more difficult to solve than symbolic questions for these students. The results of Table 4.7 showed that the incidence of language switching mostly occurred in word problems. Furthermore, through an in depth investigation of where and why language switching occurred, I found that the difficulty of a question could be a main reason for students’ language switching when interpreting the text, reading some numbers, or implementing algorithms. The evidence in support of this reason will be presented in section 4.3.1.

From the parents’ questionnaires and students’ responses to questions about language switching, I found that some students switched to L1 when reading particular numbers. Students used these numbers (in Persian) habitually, because they were familiar with them. For instance, it appeared that referring to one digit numbers in Persian was common among those students who used these numbers regularly at home. This issue will be discussed further in section 4.3.2.

In some cases, students said that being interviewed in a Persian school triggered the incidence of language switching. Being in the Persian school also reminded them of Iranian people or custom that related to the context of the word problems, such as purchasing an Iranian CD or attending an Iranian birthday party, which in turn led to language switching. Evidence to support this will be presented in section 4.3.3.

4.3.1 Difficulty in interpreting mathematical problem and/ or Difficulty in implementing particular algorithms
Two major sources of difficulty appeared to be associated with LS, difficulty in interpreting mathematics problems and/or difficulty in implementing particular algorithms. Students switched to Persian either when they had difficulty solving questions [LA5, AZ4, SH4, AS4], or when they experienced difficulty with interpreting the question [AN4, AS4, NM5, SZ4, SH4]. The evidence which supports these two sources of difficulty are presented below.
**Difficulty in interpreting mathematical problem**

For some students, LS occurred in comprehending the context of the mathematical question. As an example, one student [SH4] switched to L1 in a *hard open-ended question* involving division:

> Half of the people in a family are males. Could you draw a picture of what this family might look like?

This is evident in the following interview excerpt, where “Int”, refers to myself as the interviewer.

---

**Interview Excerpt**

Int: Did you use Persian in this question?

SH4: Yes, I used Persian in this question

Int: Could you explain which stage? Did you use it in which step?

SH4: When I had asked you for help (to interpret the question)… I said male… Instead of saying male, I said *mard* (male in Persian).

Int: Umm… Why at first, you asked some questions of me? (to Ascertain her difficulty). It’s appears to be hard for you?

SH4: I just didn’t really get the question

Int: You didn’t.

SH4: …get the question very well.

Int: Umm

SH4: Didn’t understand it.

Int: The statement was not clear to you?

SH4: Yes

Int: Okay. Because you asked me “what does this mean”. You remember? And I explained it to you…and because of this issue you switched into Persian?

SH4: Yes

---

This student was unable to understand the main context of the question, so she switched to L1 to help understand the problem.

Three students [AN4, NM5, AS4] had difficulty using English for interpreting certain numbers. For example, NM5 switched to Persian when solving an *easy symbolic* question involving 76 take away 39.
Int For example, if instead, … this question was multiplication… would you use Farsi in this question? For example 76 times 39, do you think you would use Farsi? [I was interested in finding that he switched to L1 when performing certain algorithms or he used L1 in other algorithms like multiplication]

NM5 Yes, most of the time.

Int: Ah, why do you do it in Persian?

NM5: Because it’s sometimes easier and when I come to…yeah it is easier.

Int: And English is hard for you, when you …

NM5: Yeah, sometimes when I’ve got Persian it’s just easier because I know the numbers quickly but in English I need to work it out, while in Persian it’s just normal, just it’s really easier

Int: With English is it easier, or with Farsi?

NM5: Persian

Int: With Persian is it easier?

NM5: Yes

This student had difficulty only with reading some numbers in English, so she switched to L1 to interpret some certain numbers in L1.

**Difficulty in implementing particular algorithms**

It seems that some students switched to Persian, when solving problems involving subtraction, division or multiplication [RK5, NM5, AZ4, ML4, LA5]. This suggests that the difficulty in mathematics procedures of certain algorithm(s) may prompt language switching. For example, one student switched to Persian in a hard word problem which required finding the difference between 436 and 508;

436 people went to the soccer match last week. This week 508 people went to the match. How many more people went to the soccer match this week than last week?

This is evident in the following interview excerpt

Int: Okay. Okay, What about this question? This question is about... This one, sorry, soccer, a soccer match. And in this question, I see in your checklist form you used Persian. Could you please explain this? Why did you use Persian and when?... I mean at which stage? Where?

LA5: Well, I did use it and I did say that sometimes I like saying the word *menha* (take away in Persian). That one was one of the places and once I wrote it down …the actual… like subtraction, …the actual problem (refer to Figure 4.1).
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Int: Yeh

LA5: I did do the first column in English but the rest, because I am ..., I said it in my mind in Persian. But I did write it [numbers] down in English.

Int: Could you please give an example?

LA5: Panjah (50 in Persian) menhaye Chellosheh (46 in Persian). Just kind of when with the Persian: dah (10 in Persian) menhaye (minus) seh (3 in Persian) chand mishe (How many? in Persian), ... I said, kind of Persian and English

Int: Okay, That's it. And any English word - did you use any in this question?

LA5: Yeh, here on the first column… it says it was five hundred (eight) minus four hundred and thirty six and…. eight minus six. I did that in English. Because it was really like, just really simple (first column). I quickly wrote down that number, you know, you just knew it on the top of your head. I knew that one, so I don't need to think much about it.

The work sheet, which shows her solution process, is presented below in Figure 4.1.

Figure 4.1: LA5’s work sample

It appears that in the tens column where trading (renaming) was required, because three is more than zero, she experienced a difficulty that led to language switching. However, she used the English language in the ones and hundreds columns as she found it easy. This suggests that she switched to L1 when she experienced difficulty during the mathematical procedure.

AS4 also switched to Persian, when he experienced some difficulty solving an average word problem involving the division of 780 by 8;

Eight family shared a prize of $780. How much did each family receive?

Int: What about this question? Also… you switched. It’s very interesting that you know for this question, …this question is about family and you know to use division but
just doing [implementing] division appropriately is hard for you? (refer to Figure 4.2) [According to his worksheet, it appeared that he needed to use the division algorithm, however he could not implement and complete division appropriately in this question].

AS4:    Yes, I found difficulty with division.
Int:    Division difficulty?
AS4:    I found division hard
Int:    Ah… If I change it to two digits maybe it is easier, then?
AS4:    Maybe
Int:    Did you switch into Persian if it was 2 digits… instead of seven hundred and eighty, it was seventy eight, did you use Persian or no?

[While I was writing the 2 digits number, 78 on his worksheet, he nodded his head].

AS4:    Yes, yes.
Int:    At which stage did you use Persian?
AS4:    Well, in this bit I’ve got confused. Well, after eight divided by seventy eight to which there is nine, remainder six …and I put six to sixty and I’ve got confused, because I know nothing times [times table needed there]… eight …six, …sixty [he thought about working on the reminder (60) and 8], so I transferred to Persian
Int:    Ah, because division in this situation is hard for you, you switched into Persian?
AS4:    Yes.

His problem solving on the work sheet shows that he was unable to complete division following the first remainder (six) (see Figure 4.2).

Figure 4.2: AS4’s work sample
Although this student comprehended the question and was able to make a start, in the second step which included working on the remainder (60÷8), he experienced difficulty with the eight times table and was unable to find a suitable number (7), so he switched to the Persian language.

Similarly, AZ4 switched to the L1 when experiencing difficulty solving an average word problem involving decimals and division:

Eight families shared a prize of $780. How much did each family receive?

Int: In this question, can you explain why you used Farsi?

AZ4: Because it was a bit hard. Because there…left over eight families shared it and has to be equal, so I have to use Farsi. Put 5… and you have to reach it hard, because…um…can be decimal and because point is hard…

Int: Point, [does it] hard?

AZ4: Umm, then … points, a bit hard and have to use Farsi because I did a point (decimal) in Farsi first with my mum …then, I did it in school

Int: Because you first… your mother helped you for…when you use a decimal.

AZ4: Yes

Int: [Decimal], Okay. Just with this number? For which number did you use Farsi?

AZ4: Five.

Int: Five?

AZ4: Yes.

Int: You said 97.5 [All in Persian] or say ninety-seven, point panj [only 5 in Persian]? What did you say?

AZ4: I said how many… because four was left over, I said how many eights in four, you can do so, I have to put it in the ‘point’ (decimal), so I said how many eights in four and I said panj (5 in Persian).

Int: Just for panj, because this step was difficult for you.

As can be seen when this student experienced difficulty in using decimals, he switched to the L1. Data derived from his interview also showed that, he initially learned ‘decimals’ in Persian (at home) with the help of his mother. These findings suggest that when he experienced difficulty solving problems, which were taught in Persian initially, he may use L1.
Furthermore, there were other instances in which difficulty in reading numbers in English, when implementing algorithms, was reported by students. For example, two students [AN4, SZ4] switched to Persian for reading numbers and words such as *seh* instead of ‘three’, *noh* instead of ‘nine’, and *bebar* instead of ‘subtraction’. For both students, expression of these numbers in Persian was easier than in English. AN4 switched to Persian in an *average symbolic question* involving 123 take away 39. This is evident in the following interview excerpt.

**Int:** I see in the question you…

**AN4:** Take away. This one?

**Int:** Yes, take away. Yes, a subtraction question. Did you use Persian? Yes, I see in your language checklist form, you ticked the Farsi language…Yes? (to match his language switching check list) When at that time I asked you, you said that you used both of the languages, Persian and English, yes… Okay?

**AN4:** Like how I did it?

**Int:** Yes, yes.

**AN4:** First, it’s zero take away [*sic*. You take the 20 and then you take a 20, you take the three for now away and the nine, so that's there out, …And a hundred and twenty nine take away thirty [*sic*]. So that is equal to ninety and six…[see Figure 4.3]

**Int:** At which stage did you use Farsi?

**AN4:** On the one take away nine…three

**Int:** For example you said… did you say instead of nine, you said *noh* [*9 in Persian*]?

**AN4:** *Noh seh ro bebar* [*3 take from 9, in Persian*]

**Int:** *noh seh ro bebar*?

**AN4:** Okay

**Int:** Okay okay. Or *sizdah* [*13 in Persian*]. Because you can’t take away from seh… you know? *Sizdah or seh*?

**AN4:** No, I put like the nine on top, then took away three. [refer to Figure 4.3]

**Int:** Did you use (only) *noh* [*9 in Persian*] and three (in Persian)?
AN4: What?

Int: Did you just use noh [9 in Persian] and three (in Persian)? Any other word - did you use in Persian?

AN4: No

Int: No? Just in Persian you said noh [9 in Persian] [pointed to 9 on his worksheet] Seh [3 in Persian] yes?

AN4: Yes.

Int: What about do [2 in Persian]? Did you use do [2 in Persian]? [I pointed to 2 in 123]

AN4: No

Int: No… okay. Why did you use Farsi?

AN4: Because it’s quicker, like, say … It’s quicker because when you say in English “Do you want tea”? in Iranian [Persian] it’s like chaee mikhay? Two words but in English it is four words. And I just said that’s why, because it’s quicker.

His work sheet presented below, shows his problem solving (see Figure 4.3).

Figure 4.3: AN4’s work sample

This student recorded the subtraction vertically and he may experience difficulty in implementing algorithm appropriately, as he recorded the 9 to the left of 6 and obtained 96 as an answer (he subtracted 3 from 9 instead of 9 from 3). Moreover, this student experienced difficulty with the interpreting 3 and 9 in English, so he switched to the Persian language. He believed that sometimes the expression of sentences is shorter in Persian than English. For example, chaee mikhay? is shorter than “would you like a cup of tea”, so for him it was easier
to use Persian. It seems that pronunciation of some one-digit numbers like 3 and 9 is shorter and easier in the Persian language than in English, so he preferred to use L1 for reading these numbers.

4.3.2 Familiarity with particular numbers used habitually

Familiarity with particular numbers due to habitual use in Persian was another reason for language switching. A group of students switched to Persian for certain numbers. This group habitually used Persian with these numbers when solving their assignments at home, or when were helped by a tutor or parents to solve mathematics problems in Persian. For example, one student [AY4] switched to Persian when solving a three-step, hard word problem, which involved multiplication, addition, and subtraction;

CD’s cost $9.90 each. Videos cost $8.90 each. Setareh was given $50 for her birthday. She bought two CD’s and a tape. How much of her $50 did she have left?

Int: Could you please say to me in which step [in this question] you use Persian?

AY4: I use Persian for the numbers.

Int For which numbers?

AY4: noh (9 in Persian) va (and in Persian) hasht (8 in Persian)

Int: Yes okay. Why did you use Farsi in this question? Because in…another question, previous question, also I saw nine and eight. Why didn’t you switch into Farsi in the previous one and you switched in this question?

AY4: Because I don’t know all numbers well (in Persian), yet.

Int Which numbers?

AY4: Actual whole numbers [generally more than one digit numbers]

Int Ah, actual number… you don’t know them in Farsi … and do you know one digit numbers in Farsi…?

AY4: Just one digit

Int One digit you know. Okay

AY4: And I know some 2 digits

Int You know some two digits. Could you please say which two digit numbers?

AY4: bist [20 in Persian]

Int bist
AY4: *Dah* [10 in Persian]
Int *dah*
AY4: *fekr konam noozdah* [I think, 19]

It can be seen that this student was unable to use Persian for two or three digit numbers, however, he switched to L1 for questions involving one digit numbers. The data provided about AY4’s background showed he mostly used Persian at home and his parents helped him to do mathematics homework in both L1 and L2. This suggests that one digit numbers used habitually in his home context may have prompted him to switch to L1 in this instance.

Similarly, one student [AS4], switched to Persian when he read even numbers in an *average symbolic question*, 38 x 6.

Int: Could you explain why you used language switching (to L1)?
AS4: Because first of all it had an even number in it and I am not comfortable with even numbers (in English).
Int: Even numbers?
AS4: (Yes), In Persian [nodded]. So I did use it just because I thought I might not…find my answer very well. I started… And the last bit was easy. I was writing in Persian so that’s why I didn’t do it in English…(so he used Persian for even numbers).
Int: Okay. If instead of six there was seven, did you use Persian? Did you switch to Persian? Because… instead of six… there was… seven, yes. Did you do language switching, or not?
AS4: No. No

His work sheet shows that he wrote down the numbers in Persian and solved the problem in Persian (Figure 4.4).

**Figure 4.4: AS4’s work sample**
It can be seen that this student switched to L1 with even numbers. The parent’s questionnaire and student’s responses to questions at the end of interview showed that his mother helped him in L1 to do mathematics assignments and he switched to Persian with even numbers habitually on these occasions.

As another example, RK5 switched to L1 due to familiarity with some numbers in Persian when solving a *hard word problem* involving multiplication;

Amir's garden has 15 rows of corn. There are 23 plants in each row? How many plants does he have altogether?

Int: Okay, okay…. This question is about Amir’s garden. Okay, Amir’s garden, when did you did this question, did you use Farsi?

RK5: A little bit.

Int: A little bit?

RK5: Like by accident, I said like…

Int: By accident?

RK5: Yeah, I said 3, I said seh.

Int: Three, just three?. Instead of three, you said seh.

RK5: Or panzdah (15 in Persian)

Int: Or?

RK5: Or panzdah (15 in Persian).

Int: Or panzdah (15 in Persian), instead of 15. Is there any more 15s?

RK5: That’s 15.

Int: Okay, okay…is any word (in English) hard for you to understand in this question

RK5: No

Int: Can you translate all the words to Persian in this question?

RK5: [Nodded].
According to her response to the questions at the end of interview, this student was helped by her parents to learn the times tables in Persian. This evidence indicates that she could be familiar with certain numbers used in Persian habitually, and so she switched to L1 on this occasion.

Familiarity with some words relevant to the context of the question was also a reason for language switching. For example, AY4 used the Persian language when reading words such as ‘pen’ and ‘pencil’ in an easy word problem involving three steps of multiplication, multiplication, and addition;

Ali’s mother wants to purchase 20 pens and 15 pencils. Each pen is $2.00 and each pencil is $1.00. How much money does she need to spend?

Int: This question is: “Ali’s mother wants to purchase 20 pens…” okay… and in this question did you use Farsi?

AY4: I did.

Int: For which steps did you use Farsi?

AY4: I used Farsi for like “pens” and “pencils”

Int: Ah instead of pen you said…? [to ensure that he knows the word for pen in Persian]

AY4: Instead of pen, I said khodkar (pen in Farsi)

Int: Okay. Why did you use khodkar instead of “pen”?

AY4: Ah, I know the word

Int: Why?

AY4: I need a word so I could say it, so

Int: Because you know this word you use it?

AY4: Yeah

Int: Actually you said: “ because I know [the words for] pen and pencil in Farsi and you know every word like ‘family’ or ‘happy birthday’ or some thing like this in Persian.” Why in this question, did you use pen and pencil in Farsi?

AY4: Because it was an easy question for me and I knew the word and yeah…

Int: And if you use pen and pencil in Farsi, it is easier then, or when you use pen and pencil in English? Or to be comfortable?

AY4: It isn’t really much of a difference. I just like it because the question is easy, I did use khodkar (pen) and medad (pencil)
Int: Okay. Because now you are in the Persian school, this issue doesn’t affect you? … to use pen and pencil in Farsi? [to ensure that being in the Persian school does not prompt his LS]

AY4: No, it doesn’t

As previously explained this student mainly spoke Persian at home, and also had a high proficiency in the Persian language. He might use some words like pen and pencil in Persian at home, so he was familiar with these words.

Another student [NM5] switched to L1 due to familiarity with words used habitually in Persian, when solving a hard open-ended question, involving division:

Half of the people in a family are males. Could you draw a picture of what this family might look like?

This is evident in the following interview excerpt:

Int: Okay. In this question I see you switched in Persian. Could you please explain in which step?
NM5: When I was reading, I read it in English but when I was drawing it because they are boys or males, boys and males and one of them that I was writing girl, because it was half, half …and when I read girls I read it dokhtar[girl in Persian] and in that step that I did [language switching]
Int: When you draw girls you said in your mind dokhtar.
NM5: Yes
Int: Why did you use Persian words?
NM5: Am I used it because…sometimes some word that I know I just because I normally use it in every day life. When I used it normally at my home or some thing. I said like dokhtar because I use it normally. It’s like in my head now and whenever I see it…I will think of dokhtar or girl.

This student was familiar with this particular word, “dokhtar” in Persian, so switched to L1 to express this word. In addition, data from her parents’ questionnaire and her response to the questions at the end of interview showed that she often used a mix of English and Persian in her daily activities for example, when talking on the telephone, or speaking with parents and her brother. These evidences suggest that she used Persian habitually when solving some mathematics questions.
4.3.3 Physical Environment

Another reason for LS that was evident from the analysis of the interview transcriptions was the physical environment. This operated in two ways, being in the Persian school and memory, and being in an interview environment, that has been considered (viewed) as the Hawthorne effect (Coombs & Smith, 2003). These are illustrated in turn below.

Being in the Persian school and memory

One student [NK5] switched to Persian in four word problems. The content of these word problems consisted of situations related to family events such as a birthday party or the purchase of CDs by his mother. Since these events or situations involved the use of the L1, it might have prompted language switching in the interview context. This point is illustrated in the following excerpt from the interview in relation to a hard word problem involving time.

Anna’s birthday party will start at 12:45 pm. It is now 10:50 am. How much longer does Anna have to wait?

Int: When you did this question, and you got this answer, did you use Farsi?

NK5: Ah, yeah. Because today is my birthday, and I am in the Persian school and I just used them

Int: For which word? Could you please give me an example in Persian?

NK5: tavallod [birthday in Persian]

Int: Did you say tavallod, when you got the answer?

NK5: Yes

Furthermore, there were other instances that NK5 used the Persian language. The following excerpt from his interview when solving an average open-ended question involving multiplication, addition, and subtraction, illustrates this point.

Chocolate is $2.50 and Muesli bar $1.50. Ali had $50. He bought 4 chocolates and some muesli bars. How much of his money was left?

Int: In this question, I see in your checklist form, you used Persian. Could you explain how and when?

NK5: Because here is the Persian school. Sometimes people come to sell some stuff like juice and some chocolate and then I remember them and they come into my head and I just remember that and just talk Persian in my head
When this student was interviewed in the Persian school, he was reminded of his birthday, which was held according to Iranian custom. He also remembered an Iranian salesman in the Persian school who sold snacks and chocolates at the Persian school, so he switched into Persian. It appears that his memory of this event prompted his use of the Persian language.

In the following excerpt of his interview, NK5 used English when solving an *average word problem*, because he was reminded of soccer playing in an English environment, so he did not switch to Persian.

436 people went to the soccer match last week. This week 508 people went to the match. How many more people went to the soccer match this week than last week?

The *Hawthorne effect*

Two students stated that they did not use the Persian language for mathematical problem solving in the classroom or at home. However, they switched to the Persian language in some
questions through this interview simply as a consequence of being interviewed. For example, SZ4 switched to L1 during three mathematics questions. However, she stated that she did not use the Persian language for mathematics questions anywhere else. It seems that the attention being placed on the L1 provided by the interview situation was the important factor for the LS, that is, the Hawthorne effect. This effect has been reported in some trials or tests where greater attention was paid to the participants by the investigator (The Burton Report, 2006).

An effect for an experiment has been reported for the interview environment, but not for the test or trial which was conducted in this study. This is an effect that has no causal basis, except that it is apparently due to the effect on the participants knowing they are being studied or interviewed. In this instance, this effect may be explained by the fact of the “social relationships between the researcher and their subjects” (Coombs & Smith, 2003, p. 101).

PA4 also switched to L1 during the interview. His interview was done in the Persian school. He switched to Persian in an *average symbolic question* involving 123 take away 39. As this student was expected to use the Persian language in the Persian school, he may have been influenced to switch to his L1 when he was interviewed in the context of the school. An excerpt from his interview illustrates this point.

```
Int: Why did you use sio noh, instead of 39?
PA4: …Because I need to practise in Persian
Int: Because you need to practise in Persian, yes?
PA4: Yes
Int: Why - just in this question, did you practise?
PA4: Because for me it is much easier, in English,
Int: For you, in this question, in English, is much easier (than Persian)?
PA4: In English it is easier but I need to practise more (in Persian).
Int: No, I am asking why did you use it in this question? Why didn’t you use it in that question. Just in this question, that is for subtraction, you used Persian?
PA4: Because for me it’s easier to do it in English but this time I didn’t…. I do it in Persian, I just practised this time
Int: For example, if in this question instead of subtraction, it was times… did you use Farsi? [I was interested in finding that does he switched in question involving other algorithm like multiplication]
PA4: No
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Int: No?

PA4: Because I …because the multiplication is too hard to do in Farsi [he didn’t have knowledge in Persian to performing multiplication in L1]

Int: In that question, it was hard for you to do in Farsi, yes?

PA4: Yes

Furthermore, PA4 switched to Persian when solving a **hard word problem** involving time. An excerpt of his interview on this question is provided below to illustrate the Hawthorne effect.

“Anna’s birthday party will start at 12:45 pm. It is now 10:50 am. How much longer does Anna have to wait?”

Int: Another question that you’ve switched to Farsi… is this question, question 5, sorry question 6 “Anna's happy birthday” You know… Why did you use Farsi in this question?

PA4: Because that one …because that one is easy also, it is easy to use Farsi for me.

Int: Why is it easy?

PA4: Because …for me time it is easy to read and I can do it in English or in Farsi, and I was practising in my Farsi.

It seems that being in the Persian school and / or the interview situation itself triggered the act of practising L1. As he stated, he does not use Persian to solve his mathematics problem in the Australian school or at home. However, in this Iranian environment he was provided with an opportunity to use L1 for mathematical problem solving. As he learned the different Persian language skills such as writing, reading, and speaking at Persian school, he was able to use L1 when performing the algorithm learned in Persian by his parents earlier, such as subtraction. However, he was unable to use L1 for multiplication because he not yet learned multiplication (comments from his parents’ questionnaire).

Another example of the Hawthorne effect occurred in SZ4, who switched to the L1 in an **average word problem** involving addition.

Sahar had 26 books. Her brother had 37 books. How many books did they have altogether?
Int: I see you in your checklist form you used Farsi. Yes? And you switched into Farsi. Could you explain where you used Farsi? Which word or which number did you use Farsi for or switch languages?

SZ4: I used it for the whole sum. I used for 6, 7 and 23 (230)

Int:: All of them?

SZ4: Yeah

Int: Why?

SZ4: Um… because I thought I’m doing in Iranian for a change.

Int: For a change?

SZ4: [Nodded].

Int: Why do you mean “for a change”?

SZ4: Because I always do it in English, and then I just want to do it in Iranian (Farsi).

Int: Now, for today you want to change, are making a change?

SZ4: Yeah

Int: When you do homework at home, mathematics homework, sometimes do you like to do this changing?

SZ4: For what school? English or Iranian?

Int: English?

SZ4: No.

Int: At home, when you do at home?

SZ4: No.

Int: For example, when you do mathematics homework at home, for example, you have 10 questions or 12 questions?

SZ4: [Nodded].

Int: Mathematics question and you are starting and solving them one by one, yes. Do you like to do changing, to make the changing in your way, changing to use Farsi?

SZ4: No.

It can be inferred from this excerpt that it was highly likely that this student switched to the L1 due to the interview situation. As data from her parent’s questionnaire and her response to the questions at the end of interview showed that she often used English for mathematical
problem solving in other occasions, such as with her friends and at home. Also her parents helped her in English for mathematics assignments. Therefore, she is not familiar with Persian numbers for solving mathematical questions. This may suggest that the Hawthorne effect was the reason for her language switching.

Another student [NM4], switched to L1 in response to a hard word problem involving the subtraction of three digit numbers.

436 people went to the soccer match last week. This week 508 people went to the match. How many more people went to the soccer match this week than last week?

Int: Where did you use Farsi?

NM4: When I wrote it down, I did like, char (4 in Persian), seh (3 in Persian), hasht (8 in Persian)

Int: Why did you use Farsi? Why did you use char instead of ‘four’ which you know?

NM4: I just wanted to do it in Farsi

Int: Between English and Persian, which one is easier for you?

NM4: Probably English, because I’ve got a habit of doing it, like in my homework and other stuff.

Int: Do you have a habit… in English? Why did you use Farsi, here?

NM4: I just wanted… like…to find out what is easier, or harder in Farsi in number stuff. And then, I did it in Farsi.

His work sheet shows that he wrote the numbers in Persian to start his solving (Figure 4.5).

**Figure 4.5: NM4’s work sample**

![Image of NM4's work sample]
NM4’s mother is Chinese and the main language spoken at home is English. This student used English for working with mathematical questions. However in this instance, the interview environment appears to have triggered the use of Persian for problem solving, as he said he was willing to practice in Persian in order to examine the “number stuff” in two languages.

4.4 POSSIBLE RELATIONSHIPS
According to the data from the interview transcripts and the parents’ questionnaires, I investigated, the relationship between students’ mathematics competency and their level of language proficiency, and the relationship between students’ gender and mathematics performance. Then, I examined the relationship between language switching and Year level, as well as relationship between language switching and students’ background.

4.4.1 Mathematics competency and language proficiency
As explained previously (4.1.2), based on the level of students’ proficiency in English and Persian (high/low), I categorised students into four groups: students who had a relatively high proficiency in both their languages (H/H), students who had relatively low proficiency in both their languages (L/L), and students who had high proficiency in one of their languages, defined as “one dominant” students (H/L or L/H). The level of students’ mathematics competency was also classified into three levels, high, average, and low. The number of students in each of these categories is given in Table 4.10.

<table>
<thead>
<tr>
<th>Language proficiency</th>
<th>Math competency</th>
<th>High</th>
<th>Average</th>
<th>Low</th>
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</thead>
<tbody>
<tr>
<td>H/ H</td>
<td>3 (RK5, AY4, SH4)</td>
<td>2 (PA4, BL4)</td>
<td>_</td>
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<tr>
<td>H/ L</td>
<td>1 (AZ4)</td>
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</tr>
<tr>
<td>L/ H</td>
<td>2 (LA5, NM4)</td>
<td>_</td>
<td>_</td>
<td></td>
</tr>
<tr>
<td>L/ L</td>
<td>1 (NK5)</td>
<td>2 (AS4, AN4)</td>
<td>5 (NM5, ML4, SR5, MH4, SZ4)</td>
<td></td>
</tr>
</tbody>
</table>

Results from Table 4.9 indicate that there were five students with a high proficiency in both languages who also had high or average competency in mathematics. However, five students showed low proficiency in both languages, as well as low mathematics competency. Three students demonstrated a high competency in mathematics, while they were in the one dominant group in language proficiency. Therefore, it seems that there is a relationship between proficiency in at least one language and mathematics competency for this group of
Iranian NESB students. One may expect the type of distribution evident in Table 4.10 from Cummins’ threshold hypothesis (1997), but small numbers prevent further comment. Student NK5 is clearly an anomalous result. But that is not unexpected since no co-variables have been included in this modelling.

One student however, who had a high level of mathematics competency was not proficient in either language. This suggests that for bilingual students, mathematics competency is not necessarily dependent on their language proficiency in L1 or L2 alone, but also needs cognitive ability (Bernardo, 1999; Bernardo & Calleja, 2005). This issue will be discussed further in Chapter 5.

### 4.4.2 Students’ background and Language switching

#### Language switching and Year level

Data derived from the comparative analysis showed that there may be a relationship between Year level and language switching. As previously explained, there were fourteen students who switched to L1 when solving mathematical problems. Among these fourteen students, ten students were in Year 4, while only four students were in Year 5. This suggests a possible relationship between year level and the incidence of language switching. This finding across problem type is presented in Table 4.11.

<table>
<thead>
<tr>
<th>Year level</th>
<th>Math. Questions</th>
<th>Open ended</th>
<th>Word problem</th>
<th>Symbolic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year 4</td>
<td>2 (50%)</td>
<td>10 (71.4%)</td>
<td>8 (80%)</td>
<td></td>
</tr>
<tr>
<td>Year 5</td>
<td>2 (50%)</td>
<td>4 (28.6%)</td>
<td>2 (20%)</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>4 (100%)</td>
<td>14 (100%)</td>
<td>10 (100%)</td>
<td></td>
</tr>
</tbody>
</table>

The incidence of language switching and the percentage of students who switched to their L1 in each type of mathematics question in Years 4 and 5 students showed that most students who switched to L1 were in Year 4, particularly for word problems (n=10) and symbolic questions (n=8). This suggests that for bilingual students, the more years of schooling in an ESL (English as a Second Language) educational context, the less the incidence of language switching. This is evidenced in the literature (Clarkson & Dawe, 1994) as, in later years the student’s reliance on L1 decreases, or “they come to believe that this [English] is the language of school work, including mathematics (p. 175) which consequently will decrease the proportion of language switching. This issue will be discussed further in Chapter 5.
Language switching and parents’ views

The relationship between language switching and parents’ views was examined using the demographic data regarding the use of either language at home (section 4.1.1, Tables 4.1, and 4.2).

Most parents (n=12) encouraged their children to use the Persian language at home. However, two parents asked their children to speak in English in order to improve the parents’ English. In spite of this, most parents (n=11) believed that using the Persian language for mathematics problem solving could confuse their children due to a possible interference with the teachers’ methods in Australian schools. As a consequence, most parents did not encourage their children to use the Persian language for solving mathematics problems. Furthermore, most parents used English or a combination of both English and Persian languages (n=12) when helping their children with mathematics assignments. In spite of the parents’ encouragement to use English for solving mathematics homework, students mostly (n=14) switched to L1 on at least one occasion, suggesting that there might be a relationship between students’ language switching in this study and their use of Persian at home.

4.5 SUMMARY

Demographic data showed that nearly all of the students have Iranian parents who encouraged their children to use the Persian language at home. All parents have a high expectation for the education of their children and believe that this will support the success of their children’s lives.

The results of the language tests showed that half of the students were of a low proficiency in both L1 and L2 languages, while only five students were classified as having a high level of proficiency in both languages, in terms of the criteria used for this study.

Three types of mathematics items (open ended, word problem, and symbolic questions) across three levels of difficulty (easy, average, and hard) were used to investigate mathematical competency as well as the incidence of language switching in this study.

Results showed that most students were considered to be at a high or average level of mathematics competency, while five students had a low competency level in mathematics.
Fourteen of the sixteen Iranian NESB students exhibited language switching behaviour. Language switching occurred most frequently in word problems.

Some students had difficulties solving problems, while others experienced difficulty in expressing some numbers in English. Frequent use of some words or numbers in the L1 at home, was considered as a prompt for language switching in these students. Some students switched to Persian when solving problems at the Persian school or when they were in an interview environment.

In the next chapter, the findings of this study will be compared with Clarkson’s (1996) study, in particular, and with the relevant literature, in general in order to investigate the role of language switching in mathematics performance, and the possible relationship between language proficiency and mathematics competency in bilingual students.
CHAPTER 5 — DISCUSSION

The research reported here was undertaken to explore the role of language switching in a group of Iranian NESB primary school students when solving mathematics problems. For the purpose of this study, a semi-structured interview, two language comprehension tests and a parents’ questionnaire were used.

This chapter has two major purposes: first to address the research questions posed at the outset, and second, to interpret the research findings in terms of Clarkson’s (1996) study in particular (because it was a replication study), and the literature more generally. The implications and limitations of the study will be considered in Chapter 6.

RESEARCH QUESTIONS

The research questions to be addressed by this study were:

1. To what extent do Year 4/5 Iranian NESB students use language switching when solving different types of mathematical problems?

2. What factors prompt language switching (if any) in this sample of bilingual students?

3. Is there any relationship between proficiency in the L1 (Persian) and L2 (English) languages and mathematics performance/competency?

4. What, if any, relationship exists between students’ backgrounds and language switching?

In this chapter, the mathematics performance of Iranian NESB students is discussed in terms of the research questions. Firstly, the research questions related to language switching and mathematical problem solving in three types of questions, in addition to reasons for language switching, will be considered (section 5.1). Research questions related to relationships between language proficiency and mathematics competency, and between students’ background and language switching, will be considered in section 5.2. Then, a summary of findings will be discussed (section 5.3).
5.1 LANGUAGE SWITCHING AND MATHEMATICAL PROBLEM SOLVING

Until relatively recently, mathematics has not been considered as being a language-dependent subject. However, after the publication of Cummins’ (1979) threshold hypothesis numerous studies conducted on bilingual students have revealed that proficiency in both (L1 and L2) languages (balanced bilingualism) plays a major role in academic achievement, including mathematics performance (see Clarkson, 1991, pp. 32-33). Language switching is important in bilingual education, particularly in relation to mathematics. Language switching which is now considered as a common practice in mathematics classrooms (Clarkson, 1991; Latu, 2005), can for some students facilitate mathematics problem solving. To address the first research question, the occurrence of language switching across different types of questions will be discussed in section 5.1.1. This will be followed by a discussion on the reasons for language switching (if any) in section 5.1.2.

5.1.1 To what extent do Year 4/5 Iranian NESB students use language switching when solving different types of mathematics problems.

A key question related to this study was the following: Did students switch language when attempting mathematical questions? If this was so, the study investigated what proportion of language switching occurred in relation to different types of questions and what proportion occurred in relation to item difficulty.

In this study a large proportion of the Iranian NESB students switched to L1 for at least one item when solving mathematics problems. This finding is consistent with the results of studies conducted by Clarkson (1996), and Clarkson and Dawe (1996) on several groups of bilingual students in Melbourne and Sydney, Australia, and by Latu (2005) who conducted a study on 42 NESB Year 12 high school students in New Zealand. In a study on 80 Vietnamese and 32 Italian bilingual Year 4 students in Melbourne, Clarkson (1996) reported that 53% and 28% of the students engaged in language switching, respectively. Also, Clarkson and Dawe (1996) in other studies on Vietnamese bilingual, Year 4 students in Sydney (N=57) and Melbourne (N=85) explored the incidence of language switching when these students were solving mathematical questions. They found that the proportion of language switching was 53% and 51% in Sydney and Melbourne students, respectively. Latu (2005) also reported that events of language switching occurred for learning mathematics, particularly problem solving, by most students.
However, none of the students involved in this study switched to the Persian language for all the mathematical questions attempted. Clarkson (1996) reported that a small proportion of Vietnamese (2%) and Italian (3%) bilingual students in his study used their L1 for solving all mathematical questions. The number of students in the current research was too small to draw any general conclusion. However, the findings suggest that a high proportion of the Iranian NESB students in this study preferred to use the Persian language when solving some mathematics questions.

*Language switching and problem type*

Based on the research design, three different types of mathematics questions were used in this study: symbolic, word problems, and open-ended questions. The results of the interview analysis showed that switching between languages occurred in all three types of questions. Although no statistical comparison could be made (due to the limited number of NESB students and the case study research design), this finding is in agreement with the results of the studies of Clarkson (1996) and Clarkson and Dawe (1996) who also found that language switching occurred in all three types of mathematics questions.

Results of the current study indicated that 87.5% of students switched to Persian in word problems. The proportion of language switching in symbolic and open-ended questions was 63% and 25%, respectively. Clarkson (1996) reported that 53% of Vietnamese bilingual students who studied in Melbourne, switched languages for solving word problems. The proportions for symbolic and novel problems were 43% and 41%, respectively. Clarkson and Dawe (1996) also found that 51% of Vietnamese students in Melbourne switched languages when solving word problems, and the proportion for symbolic and novel problems was 38%. It would appear that in all these studies, most students switched to the L1 when dealing with word problems. This suggests a possible relationship between the type of mathematics question and language switching.

To gain a more accurate picture of language switching in this group of bilingual students, and taking into account the unequal number of different types of questions attempted, the frequency of language switching was calculated as a proportion of the actual number of different types of problems attempted. Results confirmed that language switching occurred more often when word problems were attempted. Analyses of these data were shown in Table 4.7. As none of the previous studies discussed here, reported the data in this way, it is difficult
to make comparisons. However, it has to be acknowledged that Bernardo (1999, 2002), in this study on Filipino bilingual students in Years 2, 3, or 4 in the Philippines, that is, an EFL context, reported that the influence of language on problem solving depends on the specific components of the mathematics context, including the type of mathematics question. Therefore as a consequence, the findings of the current study lend further support to the claim that language switching occurred more frequently when the Iranian NESB students were attempting to solve word problems than when they were attempting symbolic questions.

Language switching and item difficulty in the three types of questions

Findings of this study also showed that the number of students who used the Persian language increased when average and hard word problems were administered (see Table 4.6). This finding is in line with Clarkson’s (1996) findings in relation to the 80 Vietnamese bilingual Grade 4 students studied in Melbourne. He stated that, “for word problems, with an increase in item difficulty, there was an increase in the number of students who used Vietnamese” (p. 230). However, in the current study there was no similar pattern for symbolic and open-ended questions. This finding is also consistent with Clarkson’s (1996) study, which did not find a relationship between item difficulty and the number of students who switched to L1 for symbolic and novel (open-ended) questions.

In focussing on the number of attempted questions rather than the number of students who used language switching, the proportion of language switching across different levels of item difficulty did not show a consistent pattern for the three types of question (refer to Table 4.9). In word problems with increasing item difficulty, the proportion of language switching increased. However, this proportion did not change for open-ended questions and decreased for hard symbolic questions. After reviewing the literature from a range of studies conducted on bilingual students, it appears there was no literature with which to compare these findings. However, these results further support the notion that there may be a relationship between item difficulty in word problems and language switching.

5.1.2 What factors prompted language switching (if any) in this sample of bilingual students?

Apart from the discussion outlined above on problem type and item difficulty derived from raw scores and the LS Checklist, a number of factors were found to be responsible for the incidence of language switching during mathematical problem solving from the more detailed analyses of the interview transcripts. These included difficulty in interpreting mathematical
questions and difficulty in implementing an appropriate strategy/algorithm, familiarity with particular numbers used habitually, being in the Persian school, and being in the interview environment. Each reason is discussed in more detail in relation to the relevant literature.

**Difficulty in interpreting mathematical questions and/ or difficulty in implementing particular algorithms**

The findings of this study on Iranian bilingual students indicated that the difficulty of the mathematics question could prompt language switching. This finding is in agreement with the results of Clarkson and Dawe (1996), and Clarkson (1996) studies on Vietnamese bilingual students in Sydney and Melbourne. Clarkson and Dawe (1996, p. 159) maintained that, “difficulty is certainly one dimensional. If the student feels the item is difficult …, then a switch may occur”.

Results showed that some students switched to the Persian language when dealing with the interpretation of the context of mathematical questions, while others experienced difficulty with particular algorithms.

In focussing on the difficulty with problem comprehension/interpretation, some students switched to the L1 when they could not understand the context of the question. For example, AS4 in the word problem involving time (Anna’s birthday party) stated that he was confused between a.m. (morning time) and p.m. (afternoon time), so used the Persian language to understand the question. Another student (SH4) switched to the L1 when they could not understand the meaning of a question, for example, “when I did not get it, [I] switched to Farsi [Persian]”. This finding is in line with the results of the Clarkson (1991) and Latu (2005) studies. They reported that in the first step (interpreting the text/symbol), the difficulties associated with comprehending the question may lead to errors in the solution process, which in turn could prompt language switching. For instance, Latu (2005) found that there were some signs, such as greater than (>), or less than (<), or take away (-) that may confuse bilingual (Pasifika) students, when dealing with mathematical problems. These signs may make a question difficult to interpret and “a main result … was that students have difficulty solving mathematical problems” (p. 485).

Success in the first phase of doing a mathematics problem is indicated by the formation of an accurate mental representation of the question from the context (Laborde, et. al, 1990;
Bernardo, 1999). This mainly depends on an appropriate understanding of the question particularly in a word problem (Kintsch & Greeno, 1985; Bernardo, 1999). In this regard, De Corte and Verschaffel (1987) and Bernardo (1999) found that a change in the linguistic format of a mathematics word problem text (for example, re-wording) can make the relationship between the known and unknown quantities of the problem clear. This may facilitate the student's mathematical problem solving.

In this study some students experienced difficulty in identifying and implementing an appropriate strategy/algorithm, particularly for problems involving division and subtraction. For example AZ4 switched to Persian when he carried out division involving decimals. This finding is in line with the results found by Clarkson (1996), who pointed out that,

> [bilingual] students may well choose to complete aspects of the solution process in one language and use their other language to deal with different processes. Hence some children would read or reread in one language but switch when it came to processing numbers. One or two did the opposite to this. (p. 231).

Results of the current research indicated that irrespective of the two difficult situations outlined above, expression of some numbers and/or signs in Persian was easier than in English for these students. For instance, interpreting certain numbers in English, such as three, seven, and nine, or expressing some operational signs such as subtraction (-) or multiplication (x) was difficult. While, expression of seh instead of three, haft instead of seven, noh instead of nine, bere, or bebar, or menha instead of take away and zarb instead of times in Persian is short and easy. This suggests that pronunciation in certain instances of numbers or words in the Persian language is simpler than in English, which needs further research. However, in the studies conducted by Clarkson (1996) and Clarkson and Dawe (1994, 1996) this point was not made.

**Familiarity with particular numbers used habitually**

Another factor which prompted language switching in Iranian NESB students in this study was their familiarity with some numbers (in Persian) that were used habitually at home. Most parents used the Persian language in their homes, at mealtime, or during their discussions with family members. In some cases, familiarity with some numbers could be due to the use of Persian in mathematics assignments undertaken at home. Some students were helped with mathematical homework by their parents in Persian, or a mix of L1 and L2. As a
consequence, these students were more likely to be familiar with the use of the L1 in a mathematics context, so they used their L1 quite habitually during mathematical problem solving. This factor in relation to language switching was also stated by Clarkson and Dawe (1994) in their study on different bilingual students (Italian, Arabic, Vietnamese and Cambodian) in Melbourne and Sydney. These authors (1994) reported that, “this [language switching] may occur because they habitually use their first language in most situations except when in the classroom, or quite specifically they may be helped with homework or tutored outside the classroom in their first language” (p. 175). In some instances, bilingual students simply preferred to switch to their L1 when they dealt with mathematics questions. As Clarkson and Dawe (1996) reported, “…a switch may occur … [and] students simply like to use this or that language” (p. 159).

**Physical environment**

Being in the Persian school, and the interview environment when solving mathematics questions, may have influenced language switching in this group of NESB students.

The physical environment, in this case the Persian school, triggered student memory causing them to remember an event or Iranian custom (for example, NK5 for his birthday party and purchasing a Persian CD by his mother) that was related to the context (text) of a word problem. This in turn prompted language switching. This effect was reported by Clarkson and Dawe (1996) as “students may recognize a problem, or an aspect of a problem” (p. 159) that was similar to an experience in which they have remembered a certain event or having been helped with a previous problem. If that event or help related to their L1, this can play a role in language switching in some cases. This was previously explained as “memory” by some authors. For example, Clarkson and Dawe (1996) reported that “this may prompt a switch as the student enters fully into that memory situation” (p. 159).

Another consequence of the physical environment that may encourage a few students to switch from L2 to L1 is the fact of being involved in the study. For example, SZ4 stated that she always solved mathematical questions in English, however in this instance she switched to L1 “because I just want to do it in Persian … for a change”. Another student (NM4) switched to L1 as he explained, “I want to find if solving [a mathematical problem] in Persian [language] is easy or in English [language]” during the interview time. This finding suggests that being in the interview environment prompted language switching when students were involved in solving mathematical problems. The conclusion was that the Hawthorne effect
Ch.5- Discussion

(Coombs and Smith, 2003; Merrett, 2006) was evidenced in this event. It appears there is no literature exploring the Hawthorne effect on bilingual students solving mathematical problems. Clarkson (1996) also interviewed selected NESB students after solving only three or four mathematical problems, but did not report any results for this factor. Therefore, comparison between the findings of the current study and previous studies is not possible. However, the Hawthorne effect has been more generally reported in situations where greater attention was paid to the participants by the investigator in a test, trial or study (The Burton Report, 2006). The experimental effect is due to the interview environment, but did not occur for the test or trial, which was conducted in this study. In this instance, this effect may be explained by the fact of the “social relationships between the researcher and his/ her subjects” (Coombs & Smith, 2003, p. 101). This factor had to be considered in this type of research, and therefore it is suggested that this may be an effect worth exploring further.

5.2 RELATIONSHIPS
Results of the current study revealed a possible relationship between language proficiency and mathematics competency. In addition the results also suggest a relationship between students’ background and language switching. In order to address the third and fourth research questions, the relationship between proficiency in both L1 and L2 and mathematics performance will be discussed in section 5.2.1, followed by a discussion of the relationship between students’ background and language switching in section 5.2.2.

5.2.1 Is there any relationship between proficiency in L1 (Persian) and L2 (English) languages and mathematics performance/ competency?
It was suggested that an important factor related to mathematics problem comprehension and solution is proficiency in the language in which the mathematics question is presented (Clarkson, 1992, 1996). Similarly, Clarkson (1991) stated that during word problem solving by bilingual students “between one-third or more of their errors could be classified as reading or comprehension errors, and therefore language-related (p. 32)”.

Following the occurrence of language switching and factors involved in prompting language switching, it was important to consider any relationship between L1 and L2 proficiency and mathematical competency, for this group of bilingual students. The results of the current study (refer to Table 4.5), suggested that Iranian NESB students with a high level of proficiency in both L1 and L2 showed an average or high level of mathematical performance, while those with a low proficiency in both languages generally exhibited a low level of
mathematics competency. Also students with high proficiency in one language in this study had a high level of competency in mathematics. These results are in line with Cummins’ threshold hypothesis (Cummins & Swain, 1986) and are similar to the findings of Clarkson and Dawe (1994), Clarkson (1996), and Clarkson and Dawe (1996), who reported that proficiency in both languages (balanced bilinguals) or at least in one language (one dominant bilinguals) could be associated with mathematics performance (competency) in bilingual students. Erklin and Akyel (2005) found a similar finding in an EFL context in Turkey. Although this was the case, it is possible that other factors, such as general intellectual ability or opportunity to learn, may also explain this difference.

It has to be acknowledged that in this study there was a student who performed well on the mathematics test while he showed a low proficiency in both languages (NK5). This was interpreted as an exceptional case. Although language plays an important role in mathematics achievement in bilingual students, it is not the only factor. This was also stated by Clarkson (1991) and Bernardo (1999) who noted that a student’s level of cognitive development, the ability to differentiate ideas and work with numbers, and a positive attitude toward mathematics are also considered as important factors for a high level of mathematics performance.

Students who were classified as having a low competency in mathematics often did not understand a word problem because they were unable to interpret the text of that problem. This often led the students to choose an incorrect operation or strategy that resulted in a low mathematics performance. That is, low mathematics competency in this group may not necessarily indicate a lack of mathematics skill, but may represent difficulty in comprehending the text (Bernardo, 1999).

5.2.2 What, if any, relationship exists between students’ background and language switching?

The results of this study showed that more than 85% of parents used the Persian language at home and preferred to speak Persian. Also 75% of parents encouraged their children to use Persian at home. Results showed that 88% of this group of Iranian NESB students switched to L1 when solving mathematical questions. This switching included both mathematical terms (e.g., numbers or signs) and non-mathematical terms (e.g., for “girl” or “birthday”). This result could be due to parents’ encouragement to use Persian in the home environment. This is
consistent with the literature, for example, as Saravanan (2004) has stated, out-of-school activities, particularly the interaction between family members at home, can provide enriching experiences for their children. Therefore, both the father’s and mother’s choice of language has a major impact on their child(ren)’s proficiency of language, in particular the first language (L1).

In this study, there was no student who switched to L1 for solving all mathematical items. This indicated that Iranian NESB students are more likely to use the L2 for solving mathematical questions. This finding may be due to two reasons; firstly these students are engaged in student-student and student-teacher interactions in learning mathematics in English (Roblyer & Edwards, 2000). This encouraged them to mostly use English for mathematical problem solving. Secondly, Iranian parents mostly believed that using the Persian language to help their children for mathematics assignment (homework) may interfere with the teachers’ methods or strategies. Therefore, they acknowledged the importance of the English language as the language of mathematics education. As previously mentioned (section 5.1.1) Clarkson (1996) noted that 2% of Vietnamese students and 3% of Italian students used their L1 for all mathematics questions. Although these numbers are very small, the fact that no Iranian NESB students in this sample used the Persian language for all questions may suggest that Iranian parents are more supportive of the use of English specifically in mathematics than other ethnic groups such as Vietnamese or Italian bilingual students (Clarkson, 1996). This may relate to the Iranian culture. As Clarkson and Dawe (1994) have suggested, there may be some distinctions between different groups of NESB students on the basis of language when solving mathematical questions and there is a need “to gain any other insights that may be pertinent to each culture” (p. 174). A further appreciation of the cultural heritage of mathematics, which owes a lot to Iranian customs and culture, has made Iranian parents respect mathematical achievement in their children. Therefore, they prefer to encourage the use of L2 by their bilingual children for mathematical contexts.

Iranian parents encourage their children to use the Persian language for family interactions and discussions, and the English language for academic text and discourse. Parents recognise the importance of “early mastery in the English language as a pre-requisite for educational achievement in later years (Saravanan, 2004, p.23)”.
Meanwhile, they insist on maintaining their native language to express their cultural values including practices. This was also reported by Sakamoto (2001) who states that family ties could be, “the most crucial factor for L1 maintenance for all parents” (p. 49).

Most of the parents who participated in this study had a positive attitude toward higher education for their children, as well as using and speaking the Persian language with their children. This suggests that there may be an attitude of Iranian parents of raising a child as bilingual. This finding is in line with the result of Sakamoto’s (2001) study. Sakamoto conducted research on six Japanese bilingual families in Canada and reported that important social factors are responsible for L1 maintenance. These factors included speaking Japanese at home, attending Japanese schools on weekends, parents’ limited L2 proficiency, regular visits to Japan, correspondence with friends in Japan, and Japanese stories (books and videos) shared among Japanese immigrant families. The decision of whether or not to raise a child as bilingual should be made by parents, however, this decision mostly depends on the socio-cultural aspects of immigrant people in an ESL community (Sakamoto, 2001; Saravanan, 2004).

**Year level**

Results of this study showed that among those students who switched to Persian (n=14), Year 4 students had a higher proportion of language switching than Year 5 students in word problems (71% and 29%, respectively) and for symbolic questions (80% and 20%, respectively). The findings of the current study also showed that the proportion of students having high mathematics competency in Year 4 was less than in Year 5. It is possible that this precipitated more language switching among Year 4 students than among Year 5 students, possibly as a result of the Year 4 students having had less experience in problem solving, particularly with word problems, than the Year 5 students. Findings similar to those in the current study were also reported by Clarkson and Dawe (1994), who conjectured that as students get older the frequency of language switching lessens as the students learn to respond to mathematical problems in English because English “is the language of school work, including mathematics” (p. 175). In a similar vein, Bernardo (1999), who conducted a study involving Year 2 bilingual Filipino students, reported that students made fewer comprehension errors in the upper years than in lower years. This suggests that the Year 5 students in the current study exhibited less frequent language switching when solving mathematical questions possibly because they experienced less difficulty in understanding the questions (Bernardo, 1999).
5.3 SUMMARY

The overall findings of this study points towards the existence of a relationship between the proficiency in both languages by Iranian NESB students and their level of competence in mathematics performance. Certain factors may prompt language switching to various extents across different types of questions. Factors associated with language switching in this group of bilingual students were difficulty of mathematics question (in particular word problems), familiarity with the content of the mathematics question, and the effect of the physical environment on memory in triggering the prompting of language switching, all of which provide further support for the Clarkson (1996) findings. Another factor which prompted language switching in this group of bilingual students was simply being in the interview environment – a kind of Hawthorne effect, which is not mentioned in the literature on bilingual students.

It has been reported that in a bilingual context, the language format of the mathematics problem (L1 or L2) might lead to language switching in order to comprehend the information which is needed for interpreting the question and/or implementing appropriate strategy(ies). Moreover, Bernardo (1999) also suggested that because many students, including bilingual students, experience considerable difficulty solving mathematics word problems, it might be advisable to re-word problems so that they are relatively easy to comprehend. However, it has to be acknowledged that in real life, problems are presented in a variety of forms, some of which may not be very clearly worded. Often they are problems simply because their presentation is messy. In mathematics classrooms, it is the teacher’s job to help students comprehend the various language structures in word problems – one should not try to solve the dilemma by simply avoiding it, for that just puts off the problem of comprehension. Hence, one needs to take care of advising that word problems should be always worded in simple ways.

In the present study, the findings showed that in this sample of Iranian NESB students, there may be a possible relationship between the level of language proficiency and mathematics competency. Parents’ attitudes and speaking Persian at home may contribute to the event of language switching in Iranian NESB students when solving mathematical problems.
The next chapter will present an overview of the major findings and final conclusions as well as limitations of this research, followed by implications of the study in terms of teaching and further research.
CHAPTER 6 – CONCLUSION

This study was conducted with sixteen Iranian NESB students in Grades 4 and 5 during Term 4 of the 2005 school year in Victoria. The students were interviewed and tested to investigate the incidence of language switching during mathematics problem solving and to discover the factors, which influenced this process.

Results of previous studies on bilingual ethnic groups showed that they have different patterns of language switching and different mathematics performances. Clarkson and Dawe (1994) therefore suggested to “treat such groups separately” (p. 174). No previous studies involving Iranian NESB children engaged mathematics problem solving were found in the Australian context. These two concerns prompted me to replicate Clarkson’s (1996) study with Iranian students as the sample, to address a question: that had occurred to me within my own family situation: specially, “why do my children who spend their daytime in an English-language environment, switch languages at home?” This study then was designed to address four main research questions: to what extent do Year 4/5 Iranian NESB students use language switching while solving different types of mathematical problems? What factors prompt language switching (if any) in this sample of bilingual students? Is there any relationship between proficiency in the L1 (Persian) and L2 (English) languages and mathematics performance/competency? What, if any, relationship exists between parents’ views and students’ backgrounds and language switching?

To obtain an in-depth understanding of the reasons for language switching, a qualitative approach and, in particular, a case study design was chosen. The major source of data was the transcripts of the semi-structured student interviews. These data and the results derived from the other research instruments, comprising the language proficiency tests and parents’ questionnaire, were analysed to address the research questions. In this chapter the major findings, limitations, and implications of the study will be considered.

6.1 MAJOR FINDINGS AND CONCLUSION

The results of this study confirmed Clarkson’s (1996) findings about the occurrence of language switching by bilingual students when they are involved in mathematical problem solving. Most of the Iranian bilingual children in this study used the Persian language (for at least part of a question) to facilitate their thinking when solving three types of problems. In focussing on students and/or questions, there were two important findings. Firstly, language
switching occurred more in word problems, compared to symbolic and open-ended questions. Secondly, in word problems the proportion of language switching increased as item difficulty increased. A main reason, which prompted students to switch languages was the difficulty of a problem. Detailed analysis of the case study data, revealed that when students experienced difficulty in comprehending a problem or implementing an appropriate algorithm, language switching occurred. Clarkson (1996) did not report qualitatively similar findings. Familiarity with particular numbers used habitually, and being in the Persian school or interview environment, were also found to prompt language switching.

The findings reported here also provided evidence to support Cummins’ (1979, 1991) theory in terms of the relationship between proficiency in L1 and L2 and mathematical competency. Although the sample size is too small to draw any conclusion, the results of this study showed that high proficiency in both languages may be associated with a high level of performance in mathematical problem solving. Data from the parents’ questionnaire suggested a possible influence of the use of Persian at home on the incidence of language switching in these bilingual students.

6.2 LIMITATIONS OF THE STUDY
The sample for this study, 16 Iranian bilingual students, was far too small to permit generalizations to other groups of bilingual students or to other educational systems.

In the absence of a standard comprehension test in the Persian language, two sources were used for determining the level of Persian language proficiency in this sample of Iranian NESB students. These sources were: firstly, the results of the comprehension tests drawn from relevant Persian textbooks, and secondly, a checking of these results with each student’s teacher to gain a clear picture about Persian language proficiency in each case. Given that the Persian language tests were not drawn from normative data and the teachers’ opinions were subjective in determining the level of language proficiency, the results of the Persian language tests should be interpreted cautiously.

Based on previous studies (Clarkson and Dawe, 1994, 1996), it has been suggested that to conduct such studies on bilingual students, a cohort study is a better approach. For example, a longitudinal study could be used to follow up bilingual students from Year 4 to Year 9. It may be surmised that frequency of language switching will decrease as the bilingual students continue working on mathematical problems in their L2 (English) by year 9. However, due to
limited resources and the time allotted, the investigator could not follow up the students in later years.

6.3 IMPLICATIONS

6.3.1 Implications for teaching

Based on the findings of this study, as well as previous literature on the mathematics performance of bilingual students, language proficiency in both the L1 and L2 may be associated with the mathematical competency in this group of Iranian NESB students. However, there is no guarantee. As Clarkson (1991, p.37) has stated, “it should be remembered that although language has a dominant role to play for these [bilingual] children’s success in mathematics, it is not the only important factor”.

As a considerable number of these Iranian NESB students presented low proficiency in L1, an implication for policy makers in the educational field is to improve L1 proficiency, which may be associated with mathematics performance. For this purpose, principals of Iranian schools may need to review the Persian language curriculum in order to achieve a reasonable level of proficiency in the L1 in their students.

According to findings of the current research, teachers in a multicultural classroom need to recognise that bilingual students use language switching when they experience difficulty in solving the mathematics problems. An implication could be that in classrooms that contain NESB Iranian students, more competent students could be used as a resource for teachers to help their Iranian peers experiencing difficulties in mathematical problem solving. As language switching may facilitate students’ thinking in accessing knowledge in their classroom, language switching in bilingual students should be counted as being important by teachers. In this regard, Clarkson and Dawe (1996) stated that,

in working with teachers in Australian schools there was not always a recognition of this cognitive feature of bilingualism. Often a naïve position was taken that the first language (L1) was somewhat irrelevant, although competence in the language of learning, in this context English (L2), may be important. Many non-bilingual teachers, the majority in our systems, were not really aware that their bilingual students would indeed swap languages while thinking about their class work (p. 154).

In ESL contexts, where the language of community and instruction is the L2, bilingual children face many linguistic challenges both in the school, in particular those children, who
are first generation immigrants. They experience difficulties in school achievement and communication, as they may be isolated from other students. This suggests that NESB students in an ESL context should be provided with a socio-culturally supportive (school) environment. For example, in an area where there are Iranian families living, teachers could spend more time working with these bilingual students when dealing with mathematical problems. They also could provide opportunities for Iranian parents/friends, to be helpers in the mathematics classroom, to support students’ in relation to their socio cultural needs (Molyneux, 2004).

Another possible implication for the teaching of mathematics relates to the context of the mathematics problem. That is, the text of a mathematics question could be the subject of explicit classroom negotiation and discussion. This would result in “fewer misinterpretation errors due to ambiguities in the text” (Bernardo, 1999, p. 159) and may help NESB students to comprehend and solve the question correctly.

Findings of this study indicated that most Iranian parents had a positive attitude towards education and wanted their children to achieve well at school in order that their chances of obtaining worthwhile future careers would be maximised. It could be explained through the history of mathematics and its connection with the Iranian culture. Historically huge developments in mathematics came from Iranian mathematicians who have contributed to what we know about modern mathematics (Behzad, 2005). As an example, Omar Khayyam (1044 – 1123 CE) was an outstanding mathematician and astronomer, who advanced the science of mathematics (Iran Cultural Centre, 2002)

Khayyam made major contributions in mathematics, particularly in Algebra. He classified many algebraic equations, … developed a geometrical approach to solving equations, … solved cubic equations by intersecting a parabola with a circle. Omar Khayyam was the first to develop the binominal theorem and determine binominal coefficients. … He extended Euclid’s work giving a new definition of ratios and included the multiplication of ratios. He contributed to the theory of parallel lines (Iran Chamber, 2005, p. 1).

Given this excellence of the history of mathematics in Iran, schools that contain Iranian NESB students (particularly in the Doncaster and Box Hill suburbs) could acknowledge and celebrate this background. As a result, these students may feel proud of their background, and could be motivated to improve in their mathematics learning.
Although this study involved only a small number of Iranian NESB students, the implications outlined above suggest possible developments for other ethnic groups of NESB students in educational systems in other ESL contexts, as NESB student numbers are increasing. For instance,

> Even countries that were previously dominantly monolingual, like the United States, are now confronting the language of instruction issue as a result of growing ethnic diversity in the communities and schools” (Bernardo, 1999, p. 161).

### 6.3.2 Implications for further research

As there were few eligible students available for this study, care must be taken in interpreting the results as well as generalising the findings. Thus, replicating this study on a large number of participants (if available and applicable) would be recommended.

However, extrapolating the findings regarding the event and reasons for language switching in mathematical problem solving are strengthened by the fact that the results of this replication study are consistent with the previous studies. Clarkson and Dawe (1996) reported that studies on bilingual students such as their own “may help teachers to focus on the fact that bilingual children may well switch languages for all areas of their class work, as well as for talking to their friends outside of the school” (p. 232). This suggests that one area of further research could be investigating the Iranian NESB students’ educational performance across other areas of the school curriculum, such as science.

Another possible extension of this research is the administration of an equal number of mathematics questions across the different types (symbolic, word problem, and open-ended) and item difficulty (easy, average, and hard), to provide a more complete understanding of the effect of question type and item difficulty on the proportion of language switching. However, the time, cost, and sample availability needed for this kind of research should be considered.

The results of this study did not show a clear picture of the relationship between gender and mathematics performance. This suggests that a large scale quantitative methodology might be needed to investigate the differential in results for male and females students in a bilingual context.
The number of migrant families entering Australia is increasing, and therefore one can expect the number of classrooms containing students who speak more than one language to increase correspondingly. This may necessitate an appropriate review of the school curricula. As a consequence, the educational performance of different bilingual students in Australia, and in particular their mathematics competency will need to be further investigated.

The question of the role of language switching in bilingual students’ school performance will continue to be an important topic in education, particularly in primary schools. As long as immigration exists and multicultural classrooms continue with immigrant children engaging in mathematics learning, the mathematics curriculum will continue to develop and the mathematics achievement of bilingual students will continue to be explored.
REFERENCES


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A. Mathematics Questions (Pilot Study)
B. Interview Questions (Pilot Study)
C. ACER Cloze Test Material (Pilot Study)
D. Persian Language Comprehension Test (Pilot Study)
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F. RMIT Ethics Approvals
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J. Parent Questionnaire
K. ACER Cloze Test Material (Main Study)
L. Persian Language Comprehension Test (Main Study)
M. Student Interview Questions (Main Study)
Mathematics Questions for Pilot Study

1. \(153 + 278 =\)
2. \(56 - 29 =\)
3. \(38 \times 6 =\)
4. \(428 \div 3 =\)
5. \(156 + 269 =\)
6. \(76 - 39 =\)
7. \(46 \times 8 =\)
8. \(38 \div 3 =\)
9. \(56 - 29 =\)
10. \(13 \div 3 =\)
11. \(36 \times 16 =\)
12. \(7 \times (13 + 18) =\)
13. \(428 \div 3 =\)

1. Anna’s birthday party will start 12:45pm. It is 10:50am now. How much longer does she have to wait?

2. 436 people went to the soccer match last week. This week 508 people went to the match. How many more people went to the soccer match this week than last week?

3. Anna weighed her dog last week. He weighed 27.9 kg. This week he weighed 28.2 kg. How many grams had he put on?

4. Jane was given $50 for her birthday. She bought 2 CDs and some tapes. How much of her $50 did she have left?

<table>
<thead>
<tr>
<th>CDs</th>
<th>on special</th>
<th>SALE</th>
<th>Tapes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$9.95</td>
<td>$8.90</td>
<td></td>
</tr>
</tbody>
</table>

5. Jane had 20 books. Her friends gave her 12 books. Now how many books she has got?
6. Half of the people in a family are males. What might a drawing of that family look like?

7. 15 people attended the dancing show last week. This week 26 people attended the show. How many more people attended this week compared to last week?

8. Jane had $20. Her mother gave her $5. How much money does she have now?

9. Ali plays basketball. His average number of goals per week was 17.9. Amir also plays basketball. His average was 18.2 goals per week. On average, how many more goals did Amir score than Ali each week?

10. A builder bought 6 pieces of timber. Each piece weighed 4 kg and cost $7. They were 1800mm long, 30 mm thick and 250 mm wide. He placed them one on top of the other. What was the height of the timber?

11. The school canteen shop has 5 different types of biscuits, 4 different types of bread, and 2 different types of drink that they could use to make a meal. How many different meals are possible?
Interview Questions (Pilot Study)

Research Project:

“The role of language switching in Iranian bilingual students when solving mathematical problems”

Investigator: Zahra Parvanehnezhad Shirazian
Supervisor: Dr. Dianne Siemon
School of Education, RMIT University

First name & Initials: .........................................  Code: .....................

1. What language did you use to begin to solve the problem?

2. Did you switch between languages? Yes/ no. If yes, at which stage did you switch?

3. Is there any word/ statement that would be difficult to translate directly into Persian (Farsi)?

4. Do you use Persian when you do mathematics in the classroom?

5. Do you use Persian when you do mathematics homework?

6. What language(s) do you use at home?

7. What was the first language you spoke?
Most grasshoppers are colored green and brown like the plants around them, so they are difficult to see. But their chirping song will always help you to find them.

Grasshoppers like to bask in the sun. The sunshine gives them energy, and on sunny days they are lively and leap about a lot. But in cooler weather they stay close to the earth where it is warm. It is best to look for grasshoppers in hot but cloudy weather. Then they will be out, but they will not jump as much as too much to catch.

You can catch a grasshopper in your hands, or you can use a small glass jar or tube. Just lower the jar over the grasshopper and it will crawl or hop inside—but move very slowly.

If you move quickly, the grasshopper is more likely to notice you and leap off into the grass. Where you have caught a grasshopper, you can look at it closely. A grasshopper cannot close its eyes; it cannot move them either. But as they are on the sides of its head and are very large it can see everything around it at the same time.

Although it is quick to get moving things, a grasshopper only gets a blurred and shadowy picture of the world around it.
GRASSHOPPERS

By learning about grasshoppers we can find out how to catch them.

Grasshoppers like to lie in _______________________________ because they get _______________________________ from it. They don't jump about much when it is _______________________________ because they don't have as much _______________________________________________________________. It is easier to catch grasshoppers on days that are _______________________________ and _______________________________________________________________ because they are out but they don't _______________________________.

Even when grasshoppers aren't moving you will still be able to find one because they make a __________________________________________________________. Most grasshoppers are coloured _______________________________ and _______________________________ just like the _______________________________________________________________ which makes them _______________________________.

You can use _______________________________ or _______________________________ to snap grasshoppers, but you have to move _______________________________ so that they won't see you or hear you and _______________________________.

Grasshoppers can see all around them because their eyes are _______________________________ and _______________________________. However, even though they can see all around them, they cannot _______________________________ or _______________________________ or _______________________________ or _______________________________ their eyes and the picture a grasshopper sees is _______________________________.

If you are able to catch a grasshopper, you can look at it closely and then let it go again.
LIZARDS LOVE EGGS

By Christobel Mattingley

‘Stuck!’ Tony’s mother yelled.

It was the first day of the family’s camping holiday.

With one hand, his mother grabbed up the baby from the grass by the tent flap. With the other she seized the stick of the beach umbrella. ‘Keep back!’ she called as Tony ran towards the tent.

Tony laughed and ran into the tent. ‘It’s only a lizard, Mum. I saw it walking through the grass.’

‘Are you sure?’ his mother said. ‘I saw the tip of its tail sliding into the tent.’

‘Sure,’ said Tony. ‘It’s a blue-tongue. See!’ He pointed into the tent.

The big lizard, about forty-five centimetres long, was crawling over Tony’s airbed, its blue tongue flicking.

‘Quick!’ his mother said. ‘It’ll crawl into your sleeping-bag.’ She surrendered. ‘I wouldn’t fancy sleeping with a lizard.’

Tony tweaked his sleeping-bag and the lizard slipped down onto the groundsheet, then scrambled quickly on to the next airbed.

‘Oh, no!’ said Tony’s mother. It was hers.

The lizard disapppeared into the opening of her sleeping-bag. Tony pulled the bag off to shake it outside, but before he reached the door the lizard fell out. It reared its head and hissed fiercely. The baby yelled in fear at the wide gaping mouth and the long blue tongue.

‘Poor fella,’ said Tony, as the lizard scrambled for safety into the shelter of the grocery cartons. Tony dived after it.

‘It eats the apricots, it had better look out,’ Tony’s mother said. ‘It won’t just now, Tony said. ‘We’ve made it nervous.’

‘It nervous? How do you think I feel,’ said his mother. She already felt silly about her panic in mistaking the lizard for a snake. Now she felt annoyed at seeing the tidy arrangement of her tent turned topsy-turvy as Tony hunted through it.

‘Mind the eggs,’ she called. But it was too late.

As Tony lunged to catch the lizard he stepped right in the middle of the egg-box.

Tony held up the lizard triumphantly. ‘Look. See its popy-pink belly.’

‘Look,’ replied his mother. ‘See your yellow-yellow feet.’

Tony looked at the eggs oozing from the squashed box. ‘Too bad it’s not a goanna,’ he said. ‘Goannas love eggs. It would have cleaned that up in no time.’

‘Too bad indeed,’ his mother agreed. ‘Now you’ll have to do it.’

Tony guilt the lizard in the washing-up basin. He mopped up the squelchy mess of yolks and whites with a cloth and squeezed it into the basin. The lizard’s long blue tongue flicked in and out as the thick yellow drops fell. By the time the broken eggs were cleaned up, the lizard’s stomach had swollen wide and flat between its legs. Blue-tongue lizards love eggs too!
LIZARDS LOVE EGGS

It was the first day of the family's camping holiday. Something crawled into the tent and thought it was a snake. □ 1
Mother grabbed up the baby because she thought the snake might ... Tony laughed because he knew the animal was a... □ 2-3
□ 4
It went into the tent and crawled over Tony's sleeping-bag but when Tony touched his sleeping-bag, it ran quickly onto the next one. This one belonged to... The baby yelled because he was... □ 5-6-7
□ 8
The lizard then ran in to hide in the... Because Mother made a mistake about the lizard, she felt... and she was annoyed at the... □ 9-10
Mother called out to Tony to look out for the eggs but it was too late because Tony had already... Tony felt... because he had... □ 11-12
The lizard's feet were goldy-yellow... Tony had to... the eggs. He wished the lizard would... □ 13-14-15-16
□ 17
He mopped up the mess and put it in the with the lizard. The lizard's tongue flicked in and out... all the broken eggs. So Tony found out that it's not just goannas who like eggs, so do... □ 18-19-20
AT THE ZOO

By Brian Pattem

Two new creatures had arrived at the zoo, and Class 10XA were clustered around the cage, studying them.

"Don't go so near the cage," said the teacher.

"They don't look dangerous," said one of the pupils.

"They look sweet," said another.

"They might look sweet," said the teacher, "but that's because they are young, and even the young ones are known to be quite vicious at times. They are carnivorous from a very early age, remember."

"What's carnivorous?" asked one of the pupils.

"It means they eat meat."

"Does that mean they would eat us?"

"Quite possibly," said the teacher.

"They look tame," said another pupil. "They're hardly moved since we came."

"That's because they are more interested in the box in the corner of their cage than in us," I suspect," said the teacher.

"If you put one of those boxes in front of them, they will sit still for hours. It's when you take the box away that they go a bit wild."

"Well, I think they are very sweet," said one of the class. "They look slightly like the monkeys in the other cage. Are they as intelligent?"

"Oh, no," said the teacher. "They can't do half the things the monkeys can."

"I think they are quite boring myself," said another of the pupils, "and all that pink skin--yuk! They're so ugly!"

"Maybe they'd be more interesting if they weren't gaping at that box," said the teacher.

"But they do move about, usually in the daylight. Anyway, they are part of our zoo project."

Class 10XA soon got bored looking at the new arrivals and moved along to another cage.

As they drifted away, one of the pupils asked, "Where did you say they came from?"

"I've already told you," said the teacher. "Honestly, Harson! Sometimes I think you've no brains in any of your three heads! They are from a planet called Earth, and they are called..."
AT THE ZOO

Class 10XA were on .................................. to the zoo. They were looking at a

....................................................... when their teacher warned them to

cage of new ...................................... the cage. At first, the pupils thought they looked

....................................................... but their teacher explained that

you could be quite ................................ She said that

although they were ................................, they were carnivorous

and so it was possible that they might ......................................

The teacher explained that the creatures stayed still most of the time because of

......................................................

If stopped the creatures from ..............................................................

One pupil thought the creatures looked slightly like ..................................

The teacher explained that monkeys were more intelligent than the creatures because

monkeys .............................................

Another pupil thought the creatures were ugly because of their ..............................

The teacher said they would be ........................................ in the daylight when they

would move away from their box.

She told the pupils they still had to ..................................................... the creatures,

When the class ...................................... they went to look at the next cage.

As they moved away Harsoff asked where the creatures

The teacher told Harsoff he didn't have a brain in his ........................................

Then she ........................................ that the creatures were from a place called Earth

and that they were called .........................................................

If the teacher had told Harsoff the name of the box in the corner, he would have known it

was a ...................................................
افسانه آرش کمانگیر

عمر نوروز سه‌ماهیان باز آمده بود و چه‌ها ______ بودند. آنها قصه‌هایی عمو نوروز پیر را خیلی
______ داشتند، عمو نوروز گفت:

یکی بود یکی نبود. در زمان‌های دور دشمنان یک______ محاصره کردند. آنها برای تحقیر ایرانیان تصمیم
گرفتند که یک ایرانی میری پیندازد و هر چا______ فرود آمده‌های مرز ایران باشد. همه وحشت کردند. اگر
تیر در همین نزدیکی‌ها می‌افتاد مقدار سرزمین ایران______ می‌شد. چه کسی می‌توانست این کار بزرگ را
انجام دهد. همه غمگین بودند. ناکارآمد آرش از میان مردم بیرون آمد و کفت من حاضر______ را قانع
کشید. او با نیروی تیر را آن______ کشید و رها کرد. با رها شدن نیروی بدن
بی‌جان______ به زمین افتاد.

عمر نوروز اشک‌هاش را پاک کرد و با لبخند گفت: چه‌ها من عده‌ای سوار به دنبال______ گفتند تیر
رفت و رفت و یک روز بعد در جایی دوری بی زمین آمد. آنجا مرز کشور پهن‌وار ما______ عزیز شد.

برگرفته از: شاهنامه فردوسی
**ACER PAT Maths Questions of the Main Study**

<table>
<thead>
<tr>
<th>Category</th>
<th>Easy</th>
<th>Average</th>
<th>Hard</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Addition</strong></td>
<td>Ali has 7 pencils. His teacher gives him 5 more. How many pencils does he have now?</td>
<td>Sahar had 26 books. Her brother had 37 books. How many books did they have altogether?</td>
<td>Ali’s mother bought 22.6 metres of white fabric and 16.8 metres of green fabric to make soccer flags. How much fabric did she buy altogether?</td>
</tr>
<tr>
<td><strong>Subtraction</strong></td>
<td>After 12 games of basketball Ali had scored 38 goals. Amir had scored 56 goals. How many more goals did Amir score than Ali?</td>
<td>Anna’s birthday party will start 12:45 pm. It is 10:50am now. How much longer does she have to wait?</td>
<td>436 people went to the soccer match last week. This week 508 people went to the match. How many more people went to the soccer match this week than last week?</td>
</tr>
<tr>
<td><strong>Multiplication</strong></td>
<td>Amir’s garden had 4 rows of corn. There are 9 plants in each row. How many plants does he have all together?</td>
<td>Amir’s garden had 8 rows of corn. There are 47 plants in each row. How many plants does he have altogether?</td>
<td>Amir’s garden has 15 rows of corn. There are 23 plants in each row? How many plants does he have altogether?</td>
</tr>
<tr>
<td><strong>Division</strong></td>
<td>Six friends shared 48 balloons. How many balloons did each friend get?</td>
<td>Eight families shared a prize of $780. How much did each family receive?</td>
<td>There are 489 students and 24 teachers at the school. Each bus can hold 45 passengers. How many buses will be needed to carry all of the students and teachers to the pool?</td>
</tr>
<tr>
<td><strong>Multi-step</strong></td>
<td>Ali’s mother wants to purchase 20 pens and 15 pencils. Each pen is $2.00 and each pencil is $1.00. How much money does she need to spend?</td>
<td>28 children threw 67 custard pies in 4 minutes. How many could they throw in 12 minutes?</td>
<td>CD’s cost $9.90 each. Video tapes cost $8.90 each. Setareh was given $50 for her birthday. She bought 2CD’s and a tape. How much of her $50 did she have left?</td>
</tr>
<tr>
<td><strong>Open-ended</strong></td>
<td>Zari has 10 pens. She wants to give some pens to her brother. How many pens does her brother receive?</td>
<td>Chocolate bars cost $2.50 each. Muesli bars cost $1.50 each. Ali had $50. He bought 4 chocolate bars and some muesli bars. How much money did he have left?</td>
<td>Half of the people in a family are males. Could you draw a picture of what this family might look like?</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Category</th>
<th>Addition</th>
<th>Subtraction</th>
<th>Multiplication</th>
<th>Division</th>
<th>other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Easy</td>
<td>73 + 58</td>
<td>76 - 39</td>
<td>14 x 5</td>
<td>48 ÷ 3</td>
<td>4 x (15-7)</td>
</tr>
<tr>
<td>Average</td>
<td>153 + 278</td>
<td>123-58</td>
<td>38 x 6</td>
<td>429 ÷ 3</td>
<td>7 x (13+18)</td>
</tr>
<tr>
<td>Harder</td>
<td>47 + 289 + 362</td>
<td>302-467</td>
<td>36 x 16</td>
<td>4128 ÷ 6</td>
<td>84 ÷ (19-12)</td>
</tr>
</tbody>
</table>
Ms Zahra Parvanehnezhad Shirazian

Dear Zahra

Re: Human Research Ethics Application Approval

The Design and Social Context Human Research Ethics Sub-Committee received your amended ethics application entitled “The relationship between language competency and mathematics performance of Iranian bilingual students”.

I am pleased to advise that the Chair has now approved your application as level 2-risk classification.

You are required to submit a copy of DE&T ethics approval to the secretary as soon as it is available, to be registered with your university ethics application and placed in your file.

This now completes the Ethics procedures.

You are reminded that you are required to complete an Annual/Final report, which should be forwarded to the Secretary of the DSC HRES - B at the above address not more than 12 months from date of this letter.

Should you have any queries regarding your ethics application please seek advice from the Chair of the sub-committee Assoc. Prof. Heather Fehring on 9925 7840, heather.fehring@rmit.edu.au or contact me on (03) 9925 7877 or email heather.porter@rmit.edu.au

I wish you well in your research.

Yours sincerely

Heather Porter
Secretary
Design and Social Context
Human Research Ethics Sub-Committee
Operational Unit - Bundoora
31 October 2005

Ms Zahra Shirzadian

Dear Zahra

Re: Human Research Ethics Application Approval – Register number HREC B 674 – 07/05

The Design and Social Context Human Research Ethics Sub-Committee received your amended ethics application titled 'The relationship between language competency and mathematics performance of Iranian bilingual students'.

I am pleased to advise that your application has now been approved as Risk Level 2 classification by the Chair and will this approval was ratified by the Ethics subcommittee meeting on 13 October 2005.

This now completes the Ethics procedures. Your ethics approval expires on 13 October 2008.

You are reminded that an Annual/Final report is mandatory and should be forwarded to the Portfolio Ethics Subcommittee secretary by 13 October 2006. This report is available from: URL: http://www.rmit.edu.au/rd/hrec_apply

Should you have any queries regarding your application please seek advice from the Chair of the sub-committee Assoc. Prof. Heather Fehring on 9925 7840, heather.fehring@rmit.edu.au or contact me on (03) 9925 3283 or email fiona.nolan@rmit.edu.au

I wish you well in your research.

Yours sincerely

Fiona Nolan
Acting Secretary
Design and Social Context
Human Research Ethics Sub-Committee

Cc Research Admin Officer, School of Education
SOS003098

Ms Zahra Parvanehnezhad Shirazian

Dear Ms Parvanehnezhad Shirazian

Thank you for your application of 20 September 2005 in which you request permission to conduct a research study in government schools titled: The role of language switching in the mathematics performance of Iranian bilingual students.

I am pleased to advise that on the basis of the information you have provided your research proposal is approved in principle subject to the conditions detailed below.

1. Should your institution’s ethics committee require changes or you decide to make changes, these changes must be submitted to the Department of Education and Training for its consideration before you proceed.

2. You obtain approval for the research to be conducted in each school directly from the principal. Details of your research, copies of this letter of approval and the letter of approval from the relevant ethics committee are to be provided to the principal. The final decision as to whether or not your research can proceed in a school rests with the principal.

3. No student is to participate in this research study unless they are willing to do so and parental permission is received. Sufficient information must be provided to enable parents to make an informed decision and their consent must be obtained in writing.

4. As a matter of courtesy, you should advise the relevant Regional Director of the schools you intend to approach. An outline of your research and a copy of this letter should be provided to the Regional Director.
5. Any extensions or variations to the research proposal, additional research involving use of the data collected, or publication of the data beyond that normally associated with academic studies will require a further research approval submission.

6. At the conclusion of your study, a copy or summary of the research findings should be forwarded to the Research and Development Branch, Department of Education and Training, Level 2, 33 St Andrews Place, GPO Box 4367 Melbourne 3001.

I wish you well with your research study. Should you have further enquiries on this matter, please contact Chris Warne, Project Officer, Research on (03) 9637 2272.

Dr John McSwiney
Assistant General Manager (Acting)
Research and Innovation Division

18/10/2005

enc
Dear Parent,

My name is Zahra Parvanehnezhad Shirazian. I am undertaking a Master degree by Research in the Design and Social Context Portfolio, School of Education at RMIT University. The title of my research is The Role of Language Switching in the Mathematics Performance of Iranian Bilingual Students.

This study aims to explore the relationship between competency in Persian and English languages and mathematics performance of Iranian bilingual primary students of non-English speaking background (NESB) in Melbourne, Victoria. In particular, the extent to which the Iranian students use Persian language to help them solve mathematical problems in middle to upper primary school. Bilingualism is defined as the use of two or more languages, so Iranian NESB students are as bilingual students. During the mathematical problem solving process, bilingual students swap between the first language (for example: Persian) and second language (English) which is called language switching. In this study, the role of language switching in mathematical problem solving will be investigated and the important factors which influence on mathematics performance of Iranian bilingual students will be found. This information will help teachers plan more appropriate mathematics learning experiences for these students. It also will lead to a better understanding of Iranian students' performance in mathematics.

I would like to invite you and your school child to participate in this research by completing a written questionnaire and signing a Consent Form. The questionnaire will take about fifteen minutes to complete. You will be asked to answer a number of questions about language spoken most of the time at home, parents’ expectations for your children’s education, length of time in Australia parents’ occupation (both in Australia and in Iran) and educational level.
Also, with your permission, your child will be asked to complete two language comprehension tests (Persian and English), each would take about 15 minutes and will be done in class as part of normal lessons. After these tests, your child will be asked to complete a 30 minutes mathematics test. This will be followed by a 30 minutes audio-taped interview which will include questions regarding the use of language switching during mathematical problem solving.

For confidentiality you can write your first name and initials on the questionnaire and Consent Forms. You and your child’s name will be coded in the data collection and analysis process and parents’ and students’ identities will not be disclosed in any way. You are assured that all information collected is of general nature only and it will be kept in a secure place for 5 years and then will be destroyed. The only people who will have access to the research data are myself and my supervisor.

The results of the research will be published in education journals and presented in conferences. They are likely to have important implications for teaching and learning mathematics in a multicultural education system. You and your child’s participation is voluntary and you can, if you wish, withdraw any unprocessed data from the study at any stage of the research.

I look forward to your participation in this study and thank you in advance for your assistance. Should you have any questions or concerns please feel free to contact me (Zahra) at work, phone number: or by email: Alternatively, you may contact my supervisor at the address below:

Associate Professor Dianne Siemon, School of Education, RMIT University. Phone: (03) 99257916, Fax: (03) 99257887 email: dianne.siemon@rmit.edu.au

Any complaints about your participation in this project may be directed to the Secretary, RMIT Human Research Ethics Committee, University Secretariat, RMIT, GPO Box 2476V, Melbourne, 3001. The telephone number is (03) 9925 1745. Details of the complaints procedure are available from: www.rmit.edu.au/council/hrec
16 September, 2005

RMIT HUMAN RESEARCH ETHICS COMMITTEE

Prescribed Consent Form for Persons Participating in Research Projects Involving Interviews, Questionnaires, Focus Groups or Disclosure of Personal Information

PORTFOLIO OF SCHOOL/CENTRE OF

Name of participant: 

Project Title: The role of language switching in the mathematics performance of Iranian bilingual students

Name(s) of investigators: (1) Zahra Parvanehnezhad Shirazian (2) Dr. Dianne Siemon

Phone: Phone: (03) 9925 7916

1. I have received a statement explaining the interview/questionnaire involved in this project.
2. I consent to participate in the above project, the particulars of which - including details of the interviews or questionnaires - have been explained to me.
3. I authorise the investigator or his or her assistant to interview me or administer a questionnaire.
4. I give my permission to be audio taped □ Yes □ No
5. I give my permission for my name or identity to be used □ Yes □ No
6. I acknowledge that:

(a) Having read the Plain Language Statement, I agree to the general purpose, methods and demands of the study.
(b) I have been informed that I am free to withdraw from the project at any time and to withdraw any unprocessed data previously supplied.
(c) The project is for the purpose of research and/or teaching. It may not be of direct benefit to me.
(d) The privacy of the information I provide will be safeguarded. However, should information of a private nature need to be disclosed for moral, clinical or legal reasons, I will be given an opportunity to negotiate the terms of this disclosure.
(e) The security of the research data is assured during and after completion of the study. The data collected during the study may be published, and a report of the project outcomes will be provided to RMIT University. Any information which may be used to identify me will not be used unless I have given my permission (see point 5).

Participant's Consent

Name: ____________________________ Date: ______________________

(Participant)

Name: ____________________________ Date: ______________________

(Witness to signature)

Where participant is under 18 years of age:

I consent to the participation of ____________________________ in the above project.

Signature: (1) ____________________________ Date: ______________________

(Signatures of parents or guardians)

(2) ____________________________ Date: ______________________

Name: ____________________________ Date: ______________________

(Witness to signature)

Participants should be given a photocopy of this consent form after it has been signed.
APPENDIX J

PARENT QUESTIONNAIRE

Research Project:
“The role of language switching in the mathematics performance of Iranian bilingual students”

Investigator: Zahra Parvanehnezhad Shirazian
Supervisor: Dr. Dianne Siemon

School of Education, RMIT University
******************************************************************************

First name & initial of your child: ...................................................  Code: ........

Please answer the following questions:

1. For how many years/ months have you been living in Australia?

2. What is your occupation in Australia?

3. What was your occupation in your home country?

4. What is your educational level?

5. How many years/ months did your child attend the childcare/ kindergarten before going to school?

6. Which language do you speak most of the time at home?

7. Which language do you speak around the table during meal time (breakfast, dinner, and lunch)?

8. Which language do you use in discussion with your family members?

9. Which language do you prefer to speak?

10. What language did you use when you came to Australia?
11. What do you expect for your child’s education?

12. Do you encourage your child to study hard for the purpose of a good educational outcome? (if yes, how?)

13. Do you encourage your child to use Persian language while solving mathematics? (if yes, how?)

14. Do you encourage your child to speak Persian language at home? (if yes, how?)

15. Which language do you (or a tutor) use in helping your child with homework (if any)?

Thank you for your time. If you have any further comments, please write below:

..............................................................................................................................................
..............................................................................................................................................
..............................................................................................................................................
..............................................................................................................................................
..............................................................................................................................................
..............................................................................................................................................
John Hogan is very deaf and keeps a special hearing dog to alert him to sounds like the telephone or door bell. Hearing dogs are trained to be companions to people who are deaf, home or work environment by making physical contact. For a small dog, this would be jumping on the person; for a large one, touching with paw or nose.

John's first hearing dog, Donna 1, lived for 20 years and 6 months and died in 1993. At that stage she held the record as the longest serving hearing dog in the world. She has a memorial outside Sydney Central Railway Station.

John searched for a new companion and found Donna Dingo. Donna is Australia's first certified hearing guide dingo and the second one in the world. She is the only dingo who is legally permitted to live in Sydney. John says it has taken a while for people to get used to seeing a dingo in public places. Donna is the only dingo in the history of Australian aviation who flies free-of-charge. When she travels she has her own seat in the back of a Qantas plane. Donna Dingo recently made history by being the first pet to visit the Jenolan Caves and Wildlife Reserve where a strict "no pets" policy is enforced.

Donna does an excellent job as a hearing guide. She is very tame and loves to cuddle people, especially children, but she is also a great watchdog.
DONNA DINGO

John Hogan keeps a .................................. dog to help him because he is ..................................

These dogs are trained to help their owners by giving signals about sounds such as .................................. and .................................. to way and by .................................. to them.

They alert their owners to sounds by .................................., whether their owners are in their homes or ..................................

John's .................................. lived for more than twenty years.

At Sydney Central Railway Station there is a .................................. to her ..................................

After Donna died, .................................. became John's new helper.

She is special because she is the last .................................. in

not usually permitted to live in the city. People are interested in her.

She is the only dingo who does not pay to travel on ..................................

so Donna Dingo .................................. when she was let in.

Donna Dingo does an excellent job ..................................

Although she is very .................................., she is a good as well.
FEEDING PUFF

The first cage in the row belonged to a couple of baby red river hogs which I had called Puff and Blow, and they were the most charming pair of babies imaginable. A full-grown red river hog is about the most colourful and handsome of the pig family. Its fur is a rich orange-red colour and along its back and neck is a mane of pure white hair; on the tips of its long, pointed ears are two dangling tufts of white hair. Puff and Blow, however, like all baby piglets, were striped; they were a dark chocolate brown, and their stripes were a light buttermilk yellow, running from nose to tail. This made them look like fat little wasps, as they trotted round their pen.

Puff was the first one to arrive at the camp. He was brought in one morning, sitting rather sadly in a wicker basket balanced on the head of a native hunter. He had been captured in the forest, and I soon discovered the reason for his doleful appearance was that he had eaten nothing for two days—a thing that was enough to make any self-respecting pig look down in the snout. The hunter, who had caught him, had tried to feed him on bananas but Puff was far too young for that sort of food. What he wanted was milk, plenty of it. So as soon as I had paid for him, I mixed a big bottleful of warm milk with sugar, and taking Puff on to my knees, I tried to make him drink. He was about the size of a Pekinese, with very small hooves, and a pair of sharp little tusks as well, as I soon found out to my cost.

Of course, he had never seen a feeding bottle before, and treated it with the gravest suspicion from the start. When I lifted him on to my knees and tried to put the rubber into his mouth, he decided that this was some special kind of torture I had invented for him. He screamed and squealed, kicking me with his sharp little hooves and trying to stab me with his little tusks. After the struggle between us had lasted for about five minutes, both Puff and I looked as though we had been bathed in milk, but not a single drop of it had gone down his throat.

I filled another bottle and again grasped the squealing pig firmly between my knees, wedged his mouth open with one hand and started to squirt the milk in with the other. He was so busily squeaking for help that every time the milk was squirted into his mouth, the next squeal would split it all out again. At last I was fortunate enough to get a few drops to trickle down his throat, and waited for him to get the taste of it, which he soon made apparent by stopping to yell and struggle, and by starting to smack his lips and grunt. I dribbled a little more milk into his mouth and he sucked it down greedily, and within a short while he was pulling away at the bottle as though he would never stop, while his tummy grew bigger and bigger. At length, when the last drop had disappeared from the bottle, he heaved a long sigh of satisfaction and fell into a deep sleep on my lap, snoring like a hive full of bees.

After that he was no more trouble, and after a few days had lost all his fear of humans, and would run, grunting and squeaking delightfully, to the bars of his pen when he saw me coming, and flop over on his back to have his tummy scratched. At feeding time, when he saw the bottle coming, he would push his nose through the bars and scream shrilly with excitement, and, to hear him, you would think he had never had a square meal in his life.
FEEDING PUFF

The camp had a number of cages where the animals were kept. In the first cage were two baby red river hogs called Puff and Blow. Their fur was striped in colours of ........................................ and ........................................ and ........................................ and ........................................ and ........................................ and ........................................ and ........................................ and ........................................

they had small hooves, pointed ears and sharp ........................................ ............................

When these animals grow to full size, they have ........................................ fur ........................................

except on their backs where the fur is ........................................ ............................

Puff was captured and carried in a ........................................ to the ........................................
camp by ........................................ ............................ The little animal was looking very ........................................ and ........................................ and ........................................ ............................

sad when he arrived because he hadn't ........................................ ............................

The man knew that Puff had been given ........................................ to ........................................ ............................

eat but he hadn't eaten them because he was ........................................ ............................ and ........................................ ............................

could only have ........................................ ............................ So he prepared a bottle for ........................................ ............................

Puff. When the man held him, Puff began to ........................................ ............................

The first bottle was soon empty but the little hog was still struggling and ........................................ ............................ The man filled another bottle. This ........................................ ............................
time he managed to squirt milk into Puff's mouth but every time the little hog ........................................ ............................ Eventually some milk ........................................ ............................
squealed, he ........................................ ............................

went ........................................ ............................

As soon as he ........................................ ............................ the little hog ........................................ ............................

stopped ........................................ ............................ and began to gruit and smack his ........................................ ............................
lips, Soon he was drinking and his tummy began ........................................ ............................
Puff stopped causing trouble and after a few more days he was no ........................................ ............................

longer ........................................ ............................ Whenever the man walked by, Puff ........................................ ............................

would run to the bars and ........................................ ............................ so that the man ........................................ ............................

would ........................................ ............................ Puff became excited when he saw the ........................................ ............................

man with ........................................ ............................ because this meant it ........................................ ............................

was ........................................ ............................

The little hog had settled in to living in a cage and being close to humans.
The Cats

By Joan Pepson

Jim heard a sudden hiss behind him, and almost simultaneously Socker leaped over and clapped the palm of his hand over Kevin's mouth. He used his favourite phrase, 'Shut up.'

For a long period, it seemed, they watched the cat and the cat watched them. Sometimes it licked its lips. Sometimes it blinked. Once it got up, stretched, and sat down again. But it watched them all the time. For their part they found it impossible to take their eyes from it. Then Jim got a drop of water in his eye and rubbed it. He rolled both eyes to clear his vision, and his cleared vision showed him another cat, also, was in full view and it was lying on the path behind them on the edge of the mist. This one was a grey cat and it melted into the general greyness. Idly with its head on its paws. He might have thought it asleep if its yellow eyes had not been wide open looking at them.

'There's a cat behind us,' he whispered to Socker.

Socker had nothing to say, but his face became more tight and strained. Afterwards one of the things Jim was able to remember was the way the raindrops clung like seed pearls to Socker's strong dark hair.

Not long afterwards they picked out two more cats—tabbies—side by side on the other side of the path. Their eyes, too, were fixed on them. Little by little they picked out more and more cats through the surrounding mist. They never saw them come. They never heard them. But, suddenly, there they were. The three huddled figures pressed closer together now waiting as the cats seemed to be waiting. The only difference was that the cats knew what they were waiting for.

Once Kevin whispered, 'They can't be cats. They're too big.' Socker whispered back, 'Who cares what you call them? They're there, aren't they?'

Jim wondered what would happen if he simply got up and walked off. Would they let him through? Would they let them all through? He did not think the other two would follow him and when he thought of himself alone in the mist among the cats he knew he could not do it. In any case, going on achieved nothing. He wished Willy would come. He never doubted Willy would come at last.

The mist hung about them, impenetrable, wet and silent. And the cats waited and watched, silent too. There were perhaps ten or twelve visible now and on the damp air came the smell of them; not of tomcat, but the nerve-tingling feral smell of zoo. Every now and then one would get up and shake itself free of raindrops and lie down again, and each time, when they saw the size of the standing cat, they huddled a little closer together. On the other side Kevin pressed even closer, and he was cold and beginning to tremble. The mist began to get thicker. It hung dark and oppressive overhead and pushed in on all sides. It was harder to see the cats now, but the cats apparently had no trouble seeing them, for they moved no closer. A kind of bubble burst inside Jim when he realised the mist was getting no thicker. It was simply that the light was fading. It was getting dark. The night was
coming and soon they would be able to see nothing at all. Then they would be helpless. But the cats—the cats could see in the dark. The lack of light made no difference to them.

It was when it had become too dark to see the cats’ eyes that Kevin lost his nerve. They had been sitting silent and still for so long, the target of so many yellow eyes, conscious that each tiny movement any of them made was seen and noted. Kevin had begun to whimper softly, saying his bitten hand was throbbing and that he felt ill. As usual, Socker said, ‘Shut up.’ This time it had the opposite effect. Kevin jumped up, began to make high, incomprehensible sounds and started to run down the road. In a moment he had disappeared into the mist, but they could hear his feet, still running. At the same time, as if this was what they had been waiting for, the cats came to life. They were all on their feet before Kevin had been swallowed by the mist, and Jim saw several of them bound down the road after him.

Jim shouted, ‘Kevin, stop!’ but his voice hardly carried at all through the mist. There were still cats surrounding them, and these began to move now, closing in and making a high, wavering singing sound, eerie and sinister in the deepening night. There was no chance of following Kevin if they had wanted to. At any moment they would be doing battle on their own account. Then, just as Kevin’s voice reached a higher, shiller note, something rushed out of the mist on their other side. For a moment, pressed as he was, his senses strained to their limit, Jim thought the figure that sprang towards them was taller than any normal person had a right to be, and that there was a flickering light about it. Then he blinked and looked again, and it was only Willy, running towards them and shouting in a commanding voice. As he reached them the cats drew back and their singing stopped.

‘Come with me,’ said Willy. ‘We’d better get to Kevin.’ He ran on, and Jim and Socker followed.

They ran on to Kevin almost before they saw him. He was still screaming and there were cats all round him. One had its injured hand in its mouth and another had him by the ankle. So far they had done no more. Now, as Willy arrived, they let go and drew back. But they stood, watching, tails twitching, while Kevin sank to the ground and moaned.

‘I knew you’d come,’ said Jim.

‘Get up,’ Willy said to Kevin. ‘You’re not hurt,’ Kevin stopped moaning and got up, nursing his hand. ‘It wasn’t you they’re after. But you shouldn’t have run. Don’t you know a cat will always chase anything that runs?’

‘What are they after then?’ said Socker.

Willy turned and faced him. He still looked tall in the deceptive half-light. ‘I think they’re after you, Socker,’ he said.
THE CATS

The situation that the writer is describing in this story is quite strange. The boys
were very ................................ of the cats and they were having □ 1
trouble seeing clearly because ...................................... They had □ 2
surrounded the ........................................... and were standing and □ 3
staring at them. Kevin, ........................., and Jim were □ 4
together. They were waiting for the other boy named ..................... who □ 5
Jim seemed to think could ................................... them. □ 6
When ................................ gave in to ................. and ran off, □ □ 7, 8
some of the cats ............................................. and the other □ 9
cats ...................................... Jim and Socker. The boys were □ 10
too ........................................... to run after □ □ 11, 12
until .......................................... arrived. When the boys did go to □ 13
Kevin, the cats were ......................... him, but at the □ 14
sight of ................................... they .............................. Kevin. □ □ 15, 16
This may have been because the cats □ 17
Willy told Kevin that he shouldn't have run because even though the cats chased □ 18
him they weren't ............................................ Willy thought the cats were really □ 19
and that they had only chased Kevin because cats □ 20
The boys were finally together but they still had to deal with the problem of the
cats.
THE SWAMP-CREATURE

By Patricia Wrightson

Simon scrambled down onto a log, dropped Pet's reins over a dead branch of it, and took off his shoes. He went straight to the bank at the far end, where dead purple-top rattled, like castanets when the wind blew. He broke off a thick stalk of it and went down the bank to prod in the water.

The deep hole was still out of reach. He stepped into the water at the edge, swishing in front with his stick until he could lean forward and reach into the hole. The stick was instantly twitched out of his hand and disappeared. He waited, watching for it to float to the surface. It didn't.

He went back to the bank for another stalk and tried all over again, watching closely for just one glimpse of whatever it was that had taken his stick. Nothing happened. He prodded and swished for some time, first in the water and then at dead-flowers heads on the reeds fringing the hole. He teased a water-boarman with the tip of his stick till it paddled off in a frantic zig-zag. He trailed his stick towards another—and it was twitched out of his hand again and disappeared. The twitch was so forceful and sudden that it made him jump, but he saw nothing.

He tried skittering a stick over the place as he had last time, but nothing happened. The creature in the swamp was not to be tricked; it preferred to trick Simon. 'I don't care, anyhow!' he shouted, and went stamping back to the shallow end to look for specimens, and perhaps to think.

The swamp-creature felt more alive and tricky than it had for a long time. Its yellow-green skin gleamed as it slid through the swamp, and its throat bulged with silent chuckles, a boy who thought he could trick a Pakkoork!

When Simon was hungry, he took his lunch up into the scrub. It was full of green-shadowed light and the sound of trees conversing with the wind. He sat on a wide terrace between roots, and was at once showered with falling twigs and leaves. 'Hey!' he said crossly, and brushed them off. Bulldozer noises were blown away and came billowing back. Whenever they were blown away a different sound was blown to him from the opposite direction, a distant grunting and clanking that seemed familiar. He puzzled about that between eating Edie's sandwiches and puzzling about the swamp-creature.

From time to time another shower of leaves and twigs rained down. He thought it was from the wind. They only stung a little, so he didn't bother to move. From time to time, too, there were rustlings of small paws scampering among leaves, but he could never see what made them.

The last thing in his lunch-box was an apple. He had taken one bite of it when two ideas clicked into his mind. One was that the odd sound coming and going on the wind was a grader; there must be one working along the road somewhere. The moment he recognised it he was able to stop thinking about that, and the second idea took over; a creature that could not be tricked might be coaxed. He gathered up his things at once, and took his apple back to the far end of the swamp.
He laid the apple delicately on a tuft of broken reeds just under water at the edge of the deep hole. Standing a little way back, he kept his eyes on the apple.

Nothing happened. The wind blew and the weeds swung along its path. Now it blew. the bulldozer noises to him, and now the clanking of the grader. It made a green stir of the forest on the mountain. Glancing at the forest, and from there along the mountain, Simon wondered if he could go by himself on old Pet to watch the bulldozer again... Not up the steep part, of course, but just below it; the bulldozer must be nearly through to there by now... Guiltily he looked down to the apple.

It was gone. He had been tricked again. While he stared with his mouth open something was thrown that hit his shirt, splashed back into the water, and floated there. The apple-core.

"You want to watch at!" Simon shouted angrily... and then he saw it. Just for a second something large and yellow-green shone as it turned through the water, and a golden eye winked. Clearly he heard the swamp's deep chuckle.

The Potkookok loved an apple.

Simon pounced on the core. There were little toothmarks on it. He was suddenly charmed and full of wonder. He sat on the bank for a long time, but he didn't see it again.

Instead, with a great deal of grumbling and clanking and fussing, round a corner and along the road came the grader.
THE SWAMP-CREATURE

In this story the writer describes an unusual meeting between a boy and something that lives in a swamp. When Simon arrived at the swamp he broke off a stick and walked to the water to

Suddenly the stick

Simon guessed that a creature had

after waiting and watching for a while, he decided to

see if

When the second stick disappeared,

he started throwing sticks over the same place but the creature

Simon wasn't afraid of the swamp creature. He wanted
to

The swamp creature, which was called a

trying

Simon and

the whole game

Simon could hear the sounds of leaves rustling around him and, further off, the

noises of

reminded him of the men working

along the road. As he finished

use the apple to

the apple carefully, waiting for

heard

which made him look away

When he looked back

been

As he stared,

the

He had

felt

Suddenly he

saw

was

Simon gazed at the

was

He waited for a long time but nothing more happened until the grader came along

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MATCHES

The ability to use fire sets humans apart from the animal kingdom. But creating fire when and where you need it has not always been easy. Over the centuries people have tried lots of methods to start and then control a flame.

An early fire-making device involved rubbing two sticks together. The friction from the rubbing caused the sticks to heat up and ignited tiny shavings of wood on the softer stick. Tinder, such as tiny pieces of dry grass, or fragments of dried moss or leaves, was added to the smouldering fragments until a flame was established.

Equally ancient technology was the discovery that the friction caused by knocking a piece of flint against a lump of iron produced tiny sparks of burning iron. If these sparks were directed onto some dry tinder, a small flame could be nurtured and finally used to light a fire.

This was the basis of the tinder box, a popular device used for centuries all over the world. Inside the tinder box was a piece of steel, a flint to hit it, and the tinder—sort of like the sparks to fall on. Tinder was made of almost anything. Dried fungus worked well and partly charred linen was popular. But the tinder box had drawbacks: it was not always reliable and was often very slow. On a cold, dark winter morning getting a flame could be agony. It meant striking the flint against the steel, with stiff, numb fingers. Striking a light took at least three minutes and much longer if the tinder was damp.

There were several stages to the evolution of the modern match which were based on chemical processes. In 577 AD in China, the Court of an Emperor was under siege from attacking armies. The women were desperate for tinder for their cooking fires. They discovered that thin sticks of pine dipped in sulphur would burst into flame at the touch of a spark. The sulphur was a chemical replacement for the tinder.

The idea of using chemicals to create fire did not become popular in Europe until the early 1800s. In 1780 a group of French chemists developed a fire-making device which consisted of a sealed glass tube, inside which was a piece of paper tipped with phosphorus. When the tube was broken, the oxygen in the air ignited the phosphorus. However, it was an explosive device and the fumes were poisonous. Another French invention also suffered from these drawbacks. Jean Chancel’s ‘Instantaneous Light Box’ developed in 1805. Chancellors invention consisted of pieces of wood tipped with a chemical mixture which burst into flame when dipped in a bottle of sulphuric acid.

The real breakthrough was an invention by English chemist John Walker, in 1826. He put all the fire-producing materials on the head of the match. All that was needed was to release the fire, and Walker did this by friction. When the match head was pulled quickly through a piece of tightly held sandpaper it flared up or fell off. Walker sold about 2000 of his home-made ‘friction lights’ from his chemist’s shop.

Walker’s ideas were quickly taken up. Friction matches began to be made by the millions. Inventors tried new formulas. Although friction matches were very useful, people were frightened of them. They could light by accident: step on a match and it burst into
The last important breakthrough in match invention was the safety match. Now only box. The match could light only when it was struck against the side of the

People had finally developed a safe means to create fire whenever it was required.
MATCHES

The use of fire by people has provided two main challenges:

1. First to __________________________ the flame and then to __________________________ the flame.

2. The earliest fire-making devices were similar because they relied on using ______________ to make heat, and then on the addition of ______________ in order to establish the fire.

3. This could be hard because the ingredients had to be kept very __________________________.

4. Tinder boxes were __________________________ fire-making devices. Dried mushroom were often included in a tinder box because they __________________________ because it was difficult to get a flame.

5. Many centuries ago, in China, __________________________ discovered that sticks covered in sulphur helped to start their cooking fires.

6. Hundreds of years later, the French also began to use __________________________ to create fire.

7. In 1760, fire was started by exposing ______________ to ______________.

8. Later, Chancel invented a chemical-tipped 'match' that had to be dipped in ______________.

9. Unfortunately, both of these inventions were ______________ as well as ______________.

10. John Walker's invention was an improvement on the French inventions because __________________________ were combined on the match head.

11. However, people were scared of using them because these matches could __________________________.

12. The safety match marked the last important breakthrough in the ______________.

13. The new design ensured that the fire-producing materials were ______________.
پرچم ایران

پرچم کشور ما زیباست.

پرچم کشور ماسه رنگ دارد.

رنگ بالای پرچم ایران سبز است.

رنگ وسط پرچم ایران سفید است.

رنگ پایین پرچم ایران سرخ است.

به جمله‌ها ی زیر جواب دهید

* چرا یخوت ایران کجا است؟

* پرچم ایران چند رنگ است؟

* رنگ های پرچم ایران را به نویسید.

* رنگ وسط پرچم ایران چه رنگ است؟

* کشور ایران بزرگ است یا کوچک؟
1. ماهواره شنل چیست؟
2. بررسی پیش‌بینی شرط‌های نماینده؟
3. چگونه شرط‌های قراردادی باید نگاشته شود؟
4. چگونه شرط‌های قراردادی باید نگاشته شود؟
5. چگونه بررسی پیش‌بینی شرط‌های قراردادی باید صورت گیرد؟
6. چگونه بررسی شرط‌های قراردادی باید صورت گیرد؟
7. چگونه بررسی شرط‌های قراردادی باید صورت گیرد؟
8. چگونه شرط‌های قراردادی باید صورت گیرد؟
9. چگونه بررسی شرط‌های قراردادی باید صورت گیرد؟
10. چگونه بررسی شرط‌های قراردادی باید صورت گیرد؟
آتش

در زمانهای بسیار قدیم مردم آتش را نمی‌شناسردند. همین که خورشید غروب می‌کرد و هوا تاریک می‌شد، همه می‌خوابیدند. مردم در آن زمانها از سرمای داخل غارها بناه می‌برندند. آنها آتش نداشتند که با آن خود را گرم کنند. میوه و سبزی و گوشت حیوانات را هم خام می‌خورند.

کشف آتش یکی از مهم‌ترین اتفاقهای زندگی انسان بود.

پس از کشف آتش، مردم کم کم به فاصله‌های آن پی برندند. کشف آتش زندگی مردم را تغییر داد. از آتش هم برای روش‌نابی، هم برای گرم و هم برای پختن غذا استفاده کردند. هر چه انسان بیشتر تکثیر کرد، بیشتر توانست از آتش استفاده کند. امروز در کارخانه‌های به کمک آتش ماشینها و اسباب‌های بسیار خانگی آتش همیشه دوست انسان نیست، گاهی دشمن بسیار خطرناکی هم می‌شود. آتش، چنگل‌ها و خانه‌ها را می‌سوزاند و از بین می‌برد. امروز انسان می‌داند که چگونه از آتش بموقع استفاده کند و بموقع آن را خاموش سازد.
1. پیش از کشف آتش مردم چطور زندگی می‌کردند؟
2. چگونه گویی‌های کشف آتش یکی از مهانترین اتفاق‌های زندگی انسان بود؟
3. آتش چه فاقده‌هایی برای انسان دارد؟
4. آیا آتش همیشه دوست انسان است؟
5. آتش چه خطره‌ای برای انسان دارد؟
6. اگر بپنید جایی آتش گرفته است چه می‌کنید؟
آیا روز مادرم دوست است؟ آینه زیبا نام

علیکه زیبا و با درم آر بار آک دنر. گربری زاند

زنیور آمر، بردزرم آر زنیور ترسید. زیبا زنیور، ازدیه تا

بادزم رانم. بردزرم زیبا، از برسید.

۱- آیا روز مادرم دوست است؟
۲- مادرم و دوستش، آر چه امرکن؟
۳- چرا زنیور داخل آمد؟
۴- بردزرم از چه جای ترسید؟
۵- میرا زیبا زنیور ازدیه؟
۶- چه کسی زیبا، از برسید؟
لیلا دلیش آموز حمیبی است. در رختانه لیلا و جلال در خت بزرگی

آست. روی ساخته‌ای در خت پرچم زرده لیبایی لاله دارد. این پرچم،

نرگ‌زار. هوجود به‌خصوص تولسته زرد و دانه‌های خوراکی. چوجاه؟ این

من ترسید. قربانی بناشین باید کند. بابا نیازی به نزدیکی ندارد.

بچه‌ها ثوب بلندی اضافی دوست دارند آنها در پیراهن بلندی

می‌کنند. طبیعت ماهیانین می‌توانند لحظات‌ها به‌دست.

اکثر فانانه بخشی دست بزرگی آست؟

۲. چه عیانه‌ای این درخت چیست؟

۳. به‌طور بازله رنگی خوراک؟

۴. میوه ۶۸۹ هیلیون چیست؟

۵. به‌ویژه بیزی اضافی دوست دارند؟

۶. از چه‌ها در زن بازی می‌کنند؟

۷. در پسکام پناهی ۶۹ لباسی با بید را می‌پوشاند.
APPENDIX M

STUDENT INTERVIEW

Research Project:

“The role of language switching in the mathematics performance of Iranian bilingual students”

Investigator: Zahra Parvanehnezhad Shirazian  
Supervisor: Dr. Dianne Siemon

School of Education, RMIT University

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First name & initialS: ..............................................  Code: ........

1. How did you answer the question?

2. What did you do first? Etc

3. What language did you use to begin to solve the problem?

4. Did you switch between languages? Yes/ No. If yes, at which stage did you switch?

5. If you use Persian language for doing the mathematics test, why?

6. If you used English language for doing the mathematics test, why?

7. Is there any word/ statement that would be difficult to translate directly into Persian (Farsi)?

8. Do you use Persian when you do mathematics in the classroom?

9. Do you use Persian when you do mathematics homework?

10. Do you use Persian when you speak with your friends in Saturday school?
11. Do you use Persian out of school?

12. What language(s) are spoken at home (please state the approximate percentage of each one: %)?

13. What was the first language you spoke?

Any significant/ important reactions/ point when solving mathematics problems?

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