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TWO PERSPECTIVES OF BILINGUAL STUDENTS LEARNING MATHEMATICS IN AUSTRALIA: A DISCUSSION

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In Australia there are many students in mathematics classrooms whose first language is not English. These Non English Speaking Background pupils learn their mathematics in a second or third language. Australian mathematics teachers have had little professional help with this teaching situation. Although a naive view may regard this situation as a particularly difficult learning environment for all bilingual students, the situation is more complicated. An analysis of students' performances suggests that the social situation of the two languages in question has a role to play, as does the competence that a student has in each language. The reasons why and when students use their languages to do mathematics is also explored in this paper.

Australia has since 1888 been the recipient of immigrants. From 1945 to 1995 Britain has supplied the largest population group coming to Australia. In 1995/6 immigrants from New Zealand became the largest group entering Australia, and have remained so ever since. Although English language groups have always, and still constitute by far the largest number of arrivals in Australia (38.9% in 1995), the number of non-English speaking immigrants entering Australia has continually risen since 1945.

With these changes to its population over the years, Australian society has had to respond. One particular aspect of society of interest is the school system. Within this system there is evidence that on the whole schools are committed to creating environments free of ethnic and religious hostility, and of prejudice. Indeed schools are seen as key places in which notions of tolerance and the excitement of mixing with other cultures are promoted (Cahill, 1996). They have also played a more specific role. Starting during the 1960s and reaching a peak in the late 1980s/early 1990s, there was a substantial government backed effort to provide instruction in English as a Second Language for students who came from homes where English was not spoken as a first language. However this support has since declined. Part of this decline was because the rate of increase of the total number of immigrants entering Australia had slowed considerably compared to earlier decades. Ironically, as noted above, the number of immigrants that needed this support, since they came from countries that did not have English as their first language, continued to rise.

Within this schooling environment, immigrant students from non-English speaking backgrounds (NESB) have to learn mathematics. It is this issue that the present paper reviews by discussing two relevant research studies, one of which takes the perspective of the teachers, and the other focuses on the learners.

TEACHING MATHEMATICS TO NESB STUDENTS

The role of teaching mathematics in this Australian milieu of an ever increasing, although still a minority, NESB population has not been at the forefront of research in Australia. Nevertheless there have been directions given to teachers via mathematics curriculum documents from time to time. In Victoria for example, there was no emphasis on language in the early 1980s (Ministry of Education, 1986; Education Department of Victoria, 1985). By the late 1980s there was some notice being taken with a message for teachers that they should be aware of the role that language plays in their teaching of mathematics (Ministry of Education, 1988). By 1990, an influential national document was emphasising the importance of language (Curriculum Corporation, 1990). By the mid 1990s not only was the role of language being emphasised, there was also recognition of the particular help NESB students need in learning mathematics (Board of Studies, 1995). Sadly by the late 1990s, there was little emphasis to be found on language and mathematics in general in the re-edited curriculum guidelines, and nothing on NESB students at all (Board of Studies, 2000).

These documents make an interesting contrast with the influential documents published by the National Council of Teachers of Mathematics (NCTM) in the USA over a similar period. A seminal document published by NCTM in 1980, *An agenda for action*, although not referring to the importance of language to mathematics learning in the eight recommendations, nevertheless noted the need to be conversant with the language of mathematics in various other places (NCTM, 1980). By the late 1990s, the NCTM had published a position statement on *'Mathematics for second-language learners*' that encouraged educators to identify and remove language-based barriers, and in a proactive stance suggested that language minority students must be given appropriate assistance in learning mathematics (NCTM, 1998).

Turning now to the teachers themselves, Wotley (2001) analysed the changes in Australian immigration patterns from 1950 to the present and related these to the responses of educators with influence at the top of the education system, as far as the teaching of mathematics was concerned in Victoria. Essentially she found that there were few if any overt responses by macro educators when it came to teaching mathematics to immigrants. Initially the policy of assimilation was in vogue, and hence it was assumed that children who could not speak English would in fact learn the teaching language in school reasonably quickly. Strangely few helps were provided for them. There was no assumption that mathematics needed any particular emphasis in this policy. Even when the policy changed to multiculturalism through the 1970s and various language supports were introduced to schools, there was no special emphasis given to mathematics, nor many other subject areas in the curriculum other than in the language area.

Wotley found that teachers of mathematics in the 1950s assumed that any students who did not speak English really had to learn to fit in with the Australian way of life and learn English, as soon as possible. One can feel sorry for these teachers. With the

rapid expansion of the school system, because of the baby boom and the expanded immigration schemes, they were attempting to survive in the classroom in the main, rather than trying out new ideas. The sheer growth in student numbers was nearly overwhelming for the system. However through the 1970s and up to the 1990s Wotley generally found that teachers responded to NESB students in their own ways. Few teachers accessed the few professional sessions (e.g. Clarkson, 1993a; Davis & Hunting, 1990), and resources (e.g. Thomas, 1986) that began to be provided through the second half of the 1980s and into the 1990s. The general picture emerges of a system that has had little interest in stimulating interest and research in whether NESB students need any other resources or ways of being taught compared to monolingual English speakers, in areas of the curriculum beyond the language arts. Mathematics teachers over the years have relied on their own intuition to respond to these students, as best they could. Wotley's extensive research project echoed the results of a much smaller survey conducted in the early 1990s that showed few schools in Victoria took into account the bilingualism of their students when teaching mathematics and science (Clarkson, 1995).

NESB MATHEMATICS LEARNERS

Another interesting perspective for this issue is to focus directly on the students. An ongoing study is taking this approach. The project was built around a cohort of grade 4 Vietnamese, Arabic and Italian bilingual children who were studying mathematics in Melbourne and Sydney schools. All children came from families where their non-English language was the language of choice in the home. There was no explicit use made of their non-English language in their classrooms when doing mathematics.

Cognitive Impact of Bilingualism

The first research question that was posed was 'What cognitive effect does bilingualism have on learning mathematics?' This question was derived from earlier work that showed there was some evidence to support the notion that bilingualism could be a cognitive advantage in learning mathematics if students had facility in both their languages (Clarkson, 1992; Cummins, 1991; Dawe, 1983). The present project produced similar results for the largest group of students, the Vietnamese students (Clarkson, 1996; Clarkson & Dawe, 1997). The other groups were too small for statistical analysis. It was predicted that students who had high competence in both their languages would outperform students in mathematics who were dominant in one of their languages, and these two groups would in turn outperform students who had low competence in both their languages. This predicted order was found in both instances when students were asked to complete a test of typical mathematical word problems, and then on a test of mathematical novel problems. However in an analysis of variance model, only the students who had low competence in both languages were found to be statistically different to the other two groups, when the effects of cognitive development were allowed for. The results of this study suggest

that indeed competence in English and in Vietnamese does have implications for mathematics performance for these students.

Switching Between Languages

It is one thing to find some evidence that both languages of bilingual students have implications for their performance in mathematics. However another crucial question is 'Do the bilingual students swap languages when attempting to solve mathematical problems?' The students were asked to check through all the items on a mathematical word problem test immediately they had completed it. While doing this, they were asked to indicate whether they had only used English or had also used their non-English language in thinking through their solution for each item. Results show that this did occur. For example of the 80 Vietnamese students in Melbourne, 51% reported switching to Vietnamese during the test for at least some items. Hence this switching of languages was one strategy that was in use, even though their teachers had not suggested, let alone encouraged such behaviour in their classrooms. We also wondered 'Do teachers know that their bilingual students swap languages when doing mathematics?' Anecdotal data showed that such language switching of this 'internal' nature was unknown to the teachers. Many said they had simply not suspected what was going on. This was so even for one teacher who had graduate qualifications in Teaching English as a Second Language. She indicated, with some embarrassment, that it never occurred to her that students would use this strategy, just as they did when doing language work (see also Clarkson, 1995).

Students' Reasons for Switching Languages

We then moved to the harder question of 'Why did these bilingual students swap languages when doing mathematics?' To investigate this question each student was interviewed in a one-on-one situation on his or her solution processes for 3 or 4 'novel' mathematics problems. While the student was attempting to solve the problems s/he was video taped, and it was this video that was used as a prompt when discussing with the student his/her solutions. An analysis of the interview data is still proceeding. However some initial ideas can be formed based on a number of quotes from the students. During her interview, one Vietnamese girl said (S is student):

> S1: Sometimes I like to think on my own too, but it would be horrible not to ask one of your friends if you need help. When my teacher asks me a question, and I don't know the answer, I try to think what she wants me to say. I wait and say "Mmm". … My Dad says to say "I think it's 10 Miss." … When I ask my friend in class it's different. We can talk in Vietnamese and she tells me straight away. Miss always asks me another question or stands there and says, "Think about it." Teachers never tell you what you want to know.

There are various strategies that the student is alluding to in this comment. One is her felt need of independent thought, and another is the use of friends. This student clearly has mastered the art of wait time with the hope that the teacher will tell her the answer. She also can call on remembered strategies given by powerful others, in this

instance a general response suggested by her father when she has difficulties doing mathematics in school. She can also use Vietnamese to communicate effectively with her trusted peers. Interestingly asking the teacher does not seem to be a highly regarded strategy. Hence there seems to be awareness by students of the many solution strategies they can use, including switching between languages.

The Vietnamese student quoted above indicated that she talks to her friends in their shared language because that is where she can get help quickly. Presumably the sharing of the language is part of the identifying fabric that keeps this group of friends together. Hence its use helps set an emotional tone that is conducive for group thinking. Therefore although the use of the language in this instance does not directly link to the doing of the mathematics, it certainly seems to be playing a very important indirect role. But there were other reasons too:

I: Did you reread the whole problem, or did you just say 4+6 straight away?

S2: I just said 4+6

I: Straightaway. Did you do that in English or Vietnamese?

S2: Vietnamese

I: Do you do all your numbers in Vietnamese?

S2: Yes

I: And why do you choose Vietnamese?

S2: It was sort of like easier.

Clearly one of the contexts that prompted the use of the students' first language is the difficulty of the mathematics problem. Sometimes when the problem was perceived to be hard, the student swapped languages. But, as here, it could be that the student simply thought it would be easier. Interestingly it is not just the written part of the mathematics problem for which students use their first language, but sometimes the processing of what may be regarded as straight processing of algorithms or counting.

There are also other influences that come into play. The influence of a Saturday Language School may have a role. For a number of families it is important that the children learn their first language well. Sometimes the Language School does include some mathematics in the curriculum. This can have unexpected influences. For example in one interview the student offered the following observation:

I: Are there any times when you want to change into Arabic? Tell me about those times.

S3: Long numbers.

I: Multiplication? Division?

S3: Any

I: And because of the reversal through the numbers do you find it is tricky?

S3: Yeh, 'cause sometimes you get mixed up, because English school is 6 hours and you learn more maths in Language School. Sometimes in Language School I do mistakes and I do it the other way round like the English way.

I: Oh OK and then translate it back into Arabic? (Student nods) So if you were doing multiplication, say this one, what would the first thing you do be? Would you do it in English or Arabic?

S3: Because it is small one I'd do it in English.

I: A small one, you'd do it in English?

S3: Yeh

I: A bigger one you might do in Arabic? (Student nods) OK when you're in Arabic Language School on Saturday if the difficult problem is in Arabic, would you translate it into English?

S3: Yeh

Interestingly, there is an indication here that translations can go either way, depending on the original language context. For this student, the influence of an important context, sometimes presented a difficulty rather than being of help.

The context where the students use their first language most frequently is in their home, and it is there that homework is completed. It would be normal in year 4 for Australian students to receive a small amount of homework to complete each night, although not always mathematics homework. Hence at appropriate times in the interview students were asked whether they received any help doing their mathematics homework, who might give this help, and in what language was the help offered. Although for many students there was a mixture of languages used when help was obtained, in this mix their first language was prominent. Hence some mathematics learning was completed in their first language. It also became clear that the help that students received when doing homework sometimes had implications for the students when they were doing mathematics in the classroom, as we would hope it would. But for these bilingual students the implications were somewhat different to what most of the students' teachers assumed:

I: Now did you do all that counting up in Vietnamese or in English?

S4: My mum and dad told me a Vietnamese way so I did it the Vietnamese way.

I: Did you. And is that the way they actually taught you?

S4: Yes

It turns out that mum taught mathematics in Vietnam and dad was a trained chemist. Both mum and dad helped considerably, but the conversation at home was in Vietnamese. The student often completed the calculations in Vietnamese but swapped languages with rereading since "I'm not really good at reading in Vietnamese". Here is a typical example then of when a powerful other in the student's life influence behaviour in the classroom. For other students the advice of older siblings was

evident in how and what students did in the classroom. Interestingly for this study, at times it is not just how or what students were advised to do in processing a type of mathematics problem that persists, but the language that was used in giving such advice prompts the student to switch to that language.

CONCLUSION

The classrooms in the suburbs of the large cities in Australia are often complex language environments where up to 10 different language groups may be represented. The impact of this language complexity has been of little concern to mathematics teachers and curriculum developers in the main. However bilingual students, like most students, know they have a range of techniques on hand to process mathematics problems. This includes for them the possibility of switching languages. It has come as a surprise to many teachers that this is what their bilingual students actually do in their classrooms, even though no use of languages other than English is made when teaching mathematics. The preliminary analysis confirms that students who have a high competence in both their languages have an advantage in doing mathematics. Hence schools should actively support and encourage bilingual students to extend their competence in both their languages, including when doing mathematics. This preliminary analysis has also shown again that that the solution processes of mathematics problems is complex. It appears that students do switch languages for a number of reasons, some of which are the influence of important others or situations, the difficulty of the problem itself, or just because they feel like it. But within their solution processes, the ways in which these students use their languages and why, has the potential of providing rich insights for the students themselves, as well as teachers, curriculum developers and researchers. In particular if, and if so the ways, students use to actively integrate their knowledge, particularly when similar learning has occurred in different languages, will be critical to know, and if there is possibilities for teachers to create learning situations that will encourage such integration.

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