AUSTRALIAN BILINGUAL STUDENTS AND MATHEMATICS

Philip C. Clarkson

Australian Catholic University

In Australia there are students in many Mathematics classrooms whose first language is not English. These Non English Speaking Background (NESB) pupils have to learn their Mathematics in their second or may be third language. This paper first reviews some studies focused on NESB students studying Mathematics in Australia. The paper then turns to a group of questions that centre on whether and why bilingual students might swap between their languages when engaged in doing Mathematics, and the knowledge and reaction of their English speaking teachers to this possibility. The reasons why students do this are multiple, and not always related to the cognitive task. Social explanations can be just as important.

Australia since at least 1888 has been the recipient of immigrants. About 10% of the population in 1947, rising to about 23% in 1996, were non-native born people. The total population rose from nearly 8 million to 19 million in the same period (Jupp, 1998, p.191). From 1945 to 1995 the United Kingdom has supplied the largest population group coming to Australia, and did so for each of these years. In 1995/6 immigrants from New Zealand became the largest group entering Australia, and have remained so. English language groups since 1888 have been by far the largest number of new arrivals to Australia. However, the number of non-English speaking immigrants entering Australia has continually risen since 1945. This trend was bolstered with the demise of the 'white Australian policy' in the late 1960s and its final repeal in 1972. Incidentally this was the first piece of legislation enacted by the then new Federal Australian government in 1900. Since the late 1960s the diversity of immigrants entering Australia has also increased, in particular with a sharp rise from Asian countries.

With the change of population over the years Australian society has had to respond. One particular aspect of society that has had to deal with this continuing change is the school system. There is evidence that on the whole schools are committed to creating environments free of prejudice and of ethnic and religious hostility. 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 declined through the 1990s. 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. However ironically 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.

Although it is felt by some that speaking a language other than English at home can be a disadvantage for school work, there is evidence to suggest that this is not necessarily so. For example in the Australian media in January 2002, the performances of immigrant students in their final year of schooling were highlighted. Students from NESBs, and in particular students from Asian backgrounds outperformed all other groups of students, including students born in Australia of English speaking backgrounds (Paxinos, 2002).

Teaching Mathematics to NESB Students

The role of teaching and learning Mathematics in this Australian milieu of an ever increasing, although still a minority non English Speaking population, has not always been at the forefront of research in Australia. There has been some influence with the general notion of language impacting on the learning of Mathematics, but little research on bilingual students learning Mathematics. The Mathematics curriculum documents from Victoria for example had really no emphasis on language in the early 1980s (Ministry of Education, 1981; 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), and 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 there was a retreat by the late 1990s. Little emphasis was to be found on language in the re-edited Mathematics curriculum guidelines, and nothing on NESB students at all (Board of Studies, 2000).

Further insights into the teaching of Mathematics to NESB students can be found in an analysis carried out by Wotley (2001). She first noted the changes in Australian immigration patterns from 1950 to the present. This was then related first to the responses of educators with influence at the top of the education system, and then to teachers, 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 it would appear accessed the different professional sessions and resources that began to be provided through the second half of the 1980s and into the 1990s by different Mathematics Education professional groups. For example, an excellent book was published by Jan Thomas (1986), and there were some sessions run by the Ministry of Education and at universities, as well as at the annual conference for teachers of the Mathematics Association for Mathematics (eg. Clarkson, 1993a; Davis & Hunting, 1990).

The general picture emerges of a system that has had little interest in stimulating 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 Students Learning Mathematics

Another interesting perspective to view this issue from is to focus on the students. An ongoing study is taking this approach. The project is built around a cohort of grade 4 Vietnamese, Arabic and Italian children 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, but no explicit use was made of their non-English language in learning Mathematics.

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. That research had its roots in the work of Cummins (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.

It is one thing to find some evidence that both languages of bilingual students have implications for their performance in Mathematics, it is another to work out why. Hence another question we sort an answer to was '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 clearly 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?' The anecdotal data we collected showed that such language switching of this 'internal' nature was unknown to the teachers. Many said to us 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).

We then moved to the harder question of 'Why did these bilingual students swap languages when doing Mathematics?' If we can gain some insight into this question, then it may be the further question 'Should teachers encourage the practice?' can be discussed with some confidence. 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.

An analysis of the interview data is still proceeding. However some initial ideas can be formed. During her interview, one Vietnamese girl said (Sn 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. This brief analysis is given to indicate that there is awareness by many students of the many strategies they can call on. However one of these strategies, switching languages, is of particular interest in this study.

In the above quote the Vietnamese student 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 is not directly linked to the doing of the Mathematics, it certainly seems to be playing a very important indirect role.

However there were a number of times when students indicated that they swapped between their languages during the solving process. For example;

I: Now your lips are moving a little there. What were you doing?
S2: Thinking. About 4+6
I: Did you just say 4+6?
S2: Yes
I: Did you re-read the whole problem, or did you just say 4+6 straight away?
S2: I just said 4+6
I: Straightaway? [Student nods] 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.

The reference to 'lips moving' was when both the interviewer and student were watching the video of the student when she was attempting the solution of the Mathematics problems just prior to the interview. 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 it could also be that the student simply thought it would be easier doing that particular problem in their first language. Interestingly it is not just the written language part of the Mathematics problem that students use their first language for, but sometimes the processing of what may be regarded as straight processing of algorithms, or counting.

But there are also other influences that come into play. The influence of a 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 when discussing multiplication and division:

S3: Yeh, 'cause sometimes you get mixed up, because English school is 6 hours (each week day) 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 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 in this example there was some indication again that translations can go either way, but here it seems to depend on the original language context. For this student, and a number like him, the influence of an important other, or the 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. 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 for completing homework tasks, clearly in this mix their first language was prominent. Hence some Mathematics learning was completed in their first language. As has been shown the teachers in all likelihood were not aware of this. Even if they were, they did not teach in such a manner that students were able to bridge between their languages ensuring that what they learnt about particular Mathematics concepts or processes in one language was compatible with what they were learning in the other. 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. For these students a language component was sometimes very evident:

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
I: That's interesting. So you did the calculations too (in Vietnamese)? [Student nods] And mum and dad, do they often help you with homework?
S4: Sometimes
I: And do they have different ways of doing it than in class?
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 always in Vietnamese. The student often completed the calculations in Vietnamese but swapped languages with re-reading 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 influenced behavior in the classroom. For other students the advice of older siblings were

evident in how and what students did in the classroom. Interestingly for this study, at times what is influential is not just how or what students were advised to do in processing a type of Mathematics problem that, but the language that was used in giving such advice. In turn this may prompt the student to switch to that language in another context.

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. This has come about because of the increasing non-English immigration patterns that have occurred in Australia for the last 50 years. 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 teachers that this is what many 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 shown again that that the solution processes of Mathematics problems is complex. It appears that students can 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. Interestingly a number of students volunteered the comment that this was the first time they had been asked about 'their' thinking when doing Mathematics. 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 their is possibilities for teachers to create learning situations that will encourage such integration.

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