Practice based research

Does international education risk the development of students' mother tongues?

An investigation into language use in Mathematics classrooms

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Abstract

Many see bilingual education as the path to success in a world where English is increasingly becoming the lingua franca. However this can come at the price of not developing your native tongue, especially in subjects with very specific language like Mathematics, which is largely learnt at school. In this study we made an in depth study of language use during one Mathematics class with Dutch learners in an international school. Starting with a pre survey to investigate their perceptions of language use, we went on to observe a lesson and checked our results with a post validation exercise and test. Our initial expectation was that learners would code switch into Dutch when discussing mathematical problems. However we found that they used English almost exclusively, suggesting that they lacked sufficient register in their mother tongue. While limited, our research at least suggests that the Dutch vocabulary of our students is not being adequately developed.

1. Introduction

a) Problem statement

We work in an International School, which offers the International Baccalaureate Middle Years Programme and Diploma for students from 12 – 18. Currently all subjects (except French and Spanish) are taught exclusively in English. There is currently some debate among school management about the language of instruction for Mathematics in years 1 and 2. Some have suggested creating a class composed entirely of native Dutch speakers, taught in Dutch who would take Dutch language exams. Informal interviews with the management team indicate that this debate is mainly fueled by the perception, especially among parents, that Maths is a more difficult subject. In addition many feel that Maths skills are essential for entering into the more prestigious 'science stream' at school which was felt to offer better opportunities for prestigious studies such as engineering and economics. Therefore taking Maths in English presents something of a 'risk' in terms of acquiring a more thorough knowledge of and ability in the subject. On the other hand the school is very committed to the ideas and concepts behind bilingual education and is unsure as to whether this could set an unhelpful precedent.

However before any decision could be taken regarding the language of instruction, the management team wanted answers to the following questions:

i) What language do Dutch students currently use during Math's classes?

ii) Are students able to accurately use Mathematical language in English?

The problem was that there was no data, only vague assumptions. We were therefore asked to carry out a descriptive piece of research to ascertain exactly what kind of language the students are currently using and whether or not there was evidence that, within this particular context, students' progress in the subject was in any way hindered due to language issues. This follows a key recommendation in an EU report on CLIL (Marsh, 2002) which echoes Brodie's (1989) idea

that 'every situation where the need for bilingual education arises is unique, and will require its own analysis, research and solutions'.

b) Theoretical Framework

Our theoretical research focused on 3 areas suggested by the particular problem posed by the school and our research question: "What language do students use in Mathematics classrooms in our international school?" Firstly whether or not the assumption, that the language of Mathematics posed particular issues or problems, is supported by literature. Secondly what particular kinds of language have been observed in other studies of bilingual Maths classrooms. Thirdly what learning problems researchers had encountered among bilingual students of Maths regarding language.

It seems that the intuitive suspicions of the parents and school management have some basis, as many researchers seem to agree that the 'register' of mathematics poses particular problems for learners (Morgan, 2007). Halliday (1975) defined this register as 'meanings that belong to the language of mathematics (the mathematical use of natural language, that is, not mathematics itself), and that a language must express it if it is being used for mathematical purposes' (quoted in Moschkovich, 2006). Firstly there is the issue of Mathematical lexis. There are a number of words which can be encountered in Maths, such as "set", "point", "field" or "column" that may cause confusion as they are more commonly encountered with different meanings (Moschkovich, 2006). Conversely there is other lexis that may be difficult to learn as they are so rarely used such as locutions like "square on the hypotenuse" or "least common multiple or particular". There are Latin / Greek combinations such as "coefficient", "asymptotic" or "parabola" (Cuevas, 1984). The linguistic demands placed on second language learners in Maths classrooms and the negative impact on student performance have long been acknowledged (Cuevas, 1984; Gilberto, 1984; Marsh, 2002). Recent studies in the Netherlands among minority ethnic students whose first language was not Dutch found that they were particularly disadvantaged in this subject (Van den Boer, 2003; Van Eerde & Hajer, 2009). However, there have so far been no studies on language use within Mathematics classrooms in International Schools

within the Netherlands. Given the problems students can face learning Maths in another language and a lack of available data it was clear that research into our students' language use would be both beneficial to the school and potentially to academia.

In terms of what language was used in bilingual Maths classrooms in other countries, "Code Switching" was a common feature. In studies across the world, researches have found that students regularly "code switch" or "code mix". Baker (2001) defines this as deliberately alternating between languages. For example it may be that there is a word phrase that is either better expressed in another language or is commonly used by a particular linguistic community. An example from practical experience would be Dutch teenagers using various English phrases such as "No way" or "Messed up" within a Dutch sentence. Code switching can be used either within a sentence or over a number of sentences. The line between translation, or simply using your native language is therefore a fine one, but essentially students code switch when they have the intention to revert back to another language. In the case of students within our classrooms, this language would be English. Both Baker (2001) and Mochkovich (2006) agree that this is not a sign of language deficiency with the latter saying that it is "a dynamic verbal strategy in its own right". Studies have shown that various types code switching are very common in mathematics classrooms throughout the world. Moschkovich (2005) describes a study among Latino children in the US, which indicates that bilingual learners regularly switch between languages while engaged in computation or in discussion with other learners about more difficult mathematical problems. In former British colonial countries code switching is often used by Maths teachers to create a more friendly, positive atmosphere or to the make problems / concepts for relevant to students' experiences. Learners in this studies also regularly code switched, especially when discussing more complex problems (Arthur, 1996; Lin, 1996; Merrit et al 1992; Setati, 1998). Our initial hypothesis (based on the literature and our own experience) was that our bilingual learners would also make regular use of code switching in class. This opinion was informed by the fact that as the Mathematical register was so challenging learners would switch to their native language when discussing Mathematical terms as was the case in other studies.

The third part of the research was to focus on the issue of whether or not learners encountered difficulties using the Mathematical register. When informally interviewed, colleagues could not say the extent to which their learners code switched, especially during group exercises. They agreed that their students did sometimes use Dutch in class but could not say when and for what. This information was important to know as other studies have indicated that learners who regularly code switch may be disadvantaged. May (2011) investigated language use in Malaysian schools (which have recently reintroduced English as the language of instruction), where code switching is a regular feature of Maths classrooms. He concluded that by accepting code switching within their classrooms teachers decreased their "students opportunities to engage with subject-appropriate discourse and consequently reduced their ability to function in that domain" (p17). Students who had regularly code switched were often unable to progress to higher-level exams or university where the courses are largely in English. Similar issues were found by Morgan (2007) in London where teachers were reluctant to force students to use English in Maths, giving them instead the option of using home languages. However the effect again was negative as 'by withholding specialist forms of mathematical language they are also likely to be denied access to more advanced forms of mathematics' (p241). If code switching was a regular feature of maths classrooms in international schools, Dutch learners were potentially not developing their English mathematical register sufficiently to deal with higher-level exams, which they would take in English. Research by De Bot et al (2005) indicates that once learners develop certain language norms (for example regularly using Dutch words in certain contexts), these can become fossilised within that individual's language system. This is explained through the Bilingual Interactive Activation model of lexical processing. Essentially all lexical items from both (or more) of a bilingual's languages are part of one network. If one item is activated with greater frequency it will start to become ingrained as part of someone's natural language. The second danger was that the activation of certain words will lead to the activation of other related lexical items. This could mean that learners not only begin to regularly use Dutch words but that these words, while perhaps similar in meaning to the English terms, will not carry the precise Mathematical meaning

required. Our research could therefore possibly have identified the extent to which the younger learners code switched during Maths classes, before potentially negative language usage had the chance to get fossilised within their language system.

Our literature review led to the development of two key variables based on the hypothesis that learners would regularly code switch between English and Dutch due to the difficulty of the mathematical register. Firstly what use do learners make of code switching in class? Secondly is the code switching accurate and allow learners to correctly understand and use mathematical ideas, concepts and skills? The instruments were designed to capture these variables, but the results led to them being revised as the hypothesis was found not to be true.

c) Relevance

Personal

Two of us have backgrounds in mathematics and one in English language teaching. We feel that this research topic both complements our respective experience and provides an opportunity to deepen our knowledge of CLIL. We all work and intend to continue working within the IB system so this investigation would also help broaden our understanding of how it can provide the most effective schooling for our students.

School

The school hoped to gain an insight into language use in classrooms to help decide whether or not to offer a Dutch steam for Mathematics. If there was evidence that students' progress was being in some way hindered by a failure to acquire a Mathematical register in English, it would have perhaps made sense to change the curriculum into Dutch.

Theoretical

Language use in Maths classrooms had not been investigated in this context before. We hoped to add to the debate regarding the effectiveness and consequences of code switching in Mathematics

classrooms. We also hoped to provide an insight into how learners use language in Maths classrooms in International Schools and whether this type of education was effective in developing learner's ability to use more subject specific lexis.

2. Method

a) Selection of respondents

We investigated students in their first year of secondary school, following the first year in the IB Middle Years Program. We choose this class for reasons of practicality rather than their representativeness. The school management had said that they wanted to potentially introduce a Dutch language Maths class in either year 1 or 2 and the students selected were in the only class in these years which one of us taught. Using one of our own classes made organising the research easier. In addition there were a greater proportion of our target group, i.e. native Dutch speakers, within this group than in other classes in the school. The class consisted of 25 students (16 girls and 9 boys). Dutch is the native language of 14 students. The other 11 students are international students with different backgrounds who are native speakers of English or other languages. Their ages vary from 11 to 12. The lessons which were observed were part of a lesson-series about Algebra.

b) Instruments

We applied both quantitative and qualitative methods (Tashakkori & Teddlie, 2003) to provide as full and accurate a picture of language use as possible. A pre survey was used to elicit the students' opinion of their language use and the extent to which they code switched at school and in particular in maths. An anonymous survey has the advantage of being quick and easy to administer and eliminates 'interviewer effects' (Bryman, 2004). Qualitative observations allowed us to test whether this was an accurate view of reality (Denzin and Lincoln, 2000) as well as evaluating the accuracy of their language use in Maths. A post test provided information about whether the Dutch speakers were in any way disadvantaged by their language skills. Finally a post validation exercise provided a further chance for students to comment on their language use after being presented with the results.

The approach enhanced the reliability of our results by allowing us to triangulate our data. We understand triangulation as 'a process of cross-checking findings deriving from both quantitative and qualitative research' (Bryman, 2004). The quantitative results from the pre-survey were cross-checked with the qualitative observations to give an accurate picture of language use. Our qualitative observations on the accuracy of translation and code switching were cross checked with the quantitative results from the post task test and post validation exercise.

i) Pre-survey

Our pre survey tested students' opinions about their own language use (with a focus on code switching) following May & Ong (2010). We choose closed questions because it is easier to process the answers, it enhances comparability of answers and may clarify the meaning of a question for respondents (Bryman, 2004). Reliability was checked through *stability* of the responses (Bryman, 2004). The questionnaires were given out twice, with a week's gap between but before the observations. By doing so we could check to see if the results are stable over time. A coefficient of 0.8 was considered acceptable (Bryman 2004). To test the face validity of the survey we gave it other mathematics teachers and the head of the school and asked if the questions were suitable for the purposes of the research (Bryman, 2004).

ii) Pilot

Following Bryman (2004) we did a pilot to check our equipment and test the suitability and effectiveness of the planned observation. The pilot involved a mathematical game where students would apply algebraic expressions to daily life.

1. During the exercises the students only seemed to only be using English when observed. As this did not meet the expectations of our hypothesis we thought that this might have been the result of 'reactive effects' where the "research subject's knowledge that he is participating in scholarly research may confound investigator's data" (Web et al., 1966). We also thought that any intervention by the researcher during the observation to ask questions might have similar consequences. As a

result we altered our methods in two ways. We initially wanted two observers to take semi-structured interviews (Rubin and Rubin, 1995) with the participants but changed to a non-participant observation approach where the "observer observes but does not participate" (Bryman 2004). Secondly during the observation we had two tables with recording equipment but no observer. These were compared with the results from the observed tables.

2. If there were native speakers on the same table we noticed that students only spoke English. As our research is focused on bilingual learners and the language they use we put speakers of other languages than Dutch on other tables so as not to confuse the results.

iii) Lesson Observation

To gain an accurate picture of the reality of language use in Mathematics classrooms, the frequency of code switching and the accuracy of students' language we used sound recordings and the non participant observation approach mentioned above. The observations were carried out by two researchers in order to ensure internal reliability through inter-observer consistency (LeCompte and Goetz, 1982).

iv) Validation exercise

We checked the validity of our observations through a respondent validation exercise (Bryman, 2004). This took the form of a *focused group interview* which tests "a respondent's subjective responses to a known situation in which he or she been involved and which has been analysed by the interviewer prior to the interview." (Cohen et al., 2007). In this instance we checked with the students if they believed our conclusions to be a valid representation of how they talk in class. This was non-directive and gave respondents the chance to talk about and comment on the experience (Cohen et al., 2007). By working in a group the students were not saddled with the pressure of a one to one interview with their teacher and the group discussion yielded a wide range of opinions.

v) Post test

To check whether the learners had learnt and were able to use the mathematical ideas and concepts accurately they were given a test after the observations. This allowed us to triangulate our observations regarding their language use, and compare their test results to those of native speakers of English to see if there was evidence that Dutch speakers were in any way disadvantaged.

3. Data processing

i) Pre Survey

This provided us with quantitative data regarding student perceptions of their language use. The survey focused on what languages they believed they used in different contexts (school, home, maths classes) and the extent to which they code switched. The pre survey can be said to have a high measure of reliability as the results were very stable over the two questionnaires. Across the questions there was never more than between a 4% and 8% anomaly which we consider acceptable based on literature (Bryman 2004). Colleagues at school all agreed that the questions were the right ones to ask providing an adequate degree of face validity.

ii) Observations

The observations provided us with qualitative data about the reality of language use in mathematics classrooms in our school, both in terms of the use (or rather lack of use) of code switching and the accuracy of the learners' the Mathematical register. Our approach was based on elements of grounded theory which we understand as developing conclusions or "...theory that was derived from data, systematically gathered and analysed through the research process" (Strauss and Corbin, 1998). However we acknowledge that certain elements of a more rigorous approach to grounded theory are missing from our research. Our data is based on one (or two including the pilot) observation, which means we have not fed back our initial findings into the development of new data collection instruments and further sampling (Bryman, 2004). This would of course have provided a more reliable and potentially more valid view of reality. As a result the theory

we developed must be seen as substantial as opposed to formal as it will has a far more limited 'range of applicability to substantive areas' (Bryman 2004).

To capture the data we used open coding, to "…..break down, examine, compare, conceptualise and categorize data" (Strauss and Corbin, 1990). Each code had a label given to describe a concept or 'discrete phenomena' (Bryman, 2004), associated with language use. As this was qualitative research we let our interpretation of the data define our codes instead of using codes decided in advance (Charmez, 2000). Once we had analysed and coded the transcripts of the lesson we grouped the concepts into wider categories which we believe represented the 'real world phenomena' (Bryman, 2004) of our students' language use. To check the reliability of the observations the two observers compared their results and came up with a list of suitable codes which they believed captured what had been seen. There were very few discrepancies and this was confirmed by listening again to the recordings of the groups.

iii) Post observation tests

These were examined using a bivariate analysis (Bryman, 2004) to examine relationship between the mother tongue of the students and results. We used a simple contingency table where students were grouped by language and grade.

iv) Post observation validation

We recorded what students said in response to our presentation of the results, to ensure we could check our interpretation of the discussion. As we wanted to encourage the students to comment freely on their perceptions of our results we did not intervene. We had planned to analyse the results using the same open coding approach we used with the observations, but found that the students almost unanimously agreed with the validity of the results making this unnecessary.

4. Results

a) Pre Survey

The majority of Dutch students said that they spoke either English or a mixture of Dutch and English in school (72%). However when it came to the classroom only a very small minority said that they use Dutch, in this case to either speak to the discuss mathematical problems with students (7%) or to think about them (14%). The majority stated that they either use English (to discuss mathematical problems with students - 64 % or to think in about mathematical problems – 57%) or code switched in a mixture of Dutch and English (29% said they did this for both discussing problems and thinking about them). We believed this result to be rather unrealistic, given our hypothesis that learners would regularly code switch during maths classes.

b) Observations

The results of the pre survey were found to actually be far more accurate than we had suspected. Except in certain (rather uncommon) circumstances learners very rarely code switched into Dutch and their use of the mathematical register was without exception accurate. We initially grouped relevant sections of the transcripts/observations into 16 different codes, which were then grouped into following three more general categories.

A. Students use English for Mathematics register (either in Dutch or in English sentences).

English was predominantly used but even in Dutch sentences code switching was in English (shown in bold):

1. Why is the barycenter[1] always closer to the larger object?
2. If you look at the equation you will see that …
1. eh? What? I don't understand it. Ik begrijp er niks van.
2. Kijk, we hebben deze ***equation****, op de* ***numerator*** *er is d de* ***distance*** *en dat* ***times*** *de* ***mass*** *van de grootste planeet.*

[1] The center of mass or barycenter is the weighted average location of all the mass in a body or group of bodies

B. Students switch to Dutch when they area frustrated, angry, need reassurance etc. but quickly switch back to English.

This occurred infrequently, but in this instance code switching into Dutch is used for some mathematical terms (in bold), however it caused some confusion:

1. I don't understand it. Ik begrijp niks van.
2. Do you want me to explain it in Dutch?
1. ja
*2. de barycenter is deze **vergelijking**.*
*1. wat is een **vergelijking**?*
2. an equation
1. ok, maar waarom is X hier en niet Y
2. omdat het gaat over de afstand van X naar Y en niet andersom.
1. ok, nu begrijp ik het wel.
2. but which value do we have to give to X and Y?
1. X is half the mass of earth and Y three times the mass of earth.
3. no, Y is four times.
1. aha
2. ok, what about the distance between the objects?

However there were times when learners used English even when they were stressed. For example in the following instance the 2nd student was observed to be rather frustrated but did not switch back into Dutch. For example:

1: To calculate the barycenter
2: the barycenter of what? Oh I don't get it anymore
3: dividing by x plus y
1: you have to replace
2: but, if x equals 5 and y equals 6
4: exactly and that's what you replace in the equation
2: but we don't know the barycenter
1: yes you do
2: oh you are right, great

What is important to note is that in nearly every instance English, not Dutch words were used for mathematical lexis. This indicates that

learners have something of a linguistic gap in their native language. In less than 5% of the instances when students were discussing mathematical problems did they use a Dutch word for Mathematical lexis.

C. Students use Dutch for social purposes.

This was particular apparent at the beginning of the lesson when the students in Dutch groups spoke their native language until the teacher announced the beginning of class. At this point they immediately switched to English which they then spoke for the majority of the rest of the lesson. As soon as the bell had sounded the learners were observed speaking in Dutch:

1. ok guys, you can start packing you stuff and get ready for your next lesson.
2. Eindelijk, welke les hebben we nu?
1. Engels.
2. heb je de huiswerk gedaan?
1. Ja, maar niet alles.
2. kom, we moeten gaan.

The learners very much seem to conform to Valdes-Fallis' definition of bilinguals as people who "...use one of their languages for certain functions and the other for other functions or situations" (Valdes-Fallis 1978). In this case learners seem to see the classroom as the domain for English.

c) Post task test

No significant differences were found in the results (Figure 1) of the post task scores achieved by Dutch and English speakers as show in the table below. This indicates that the Dutch learners are not disadvantaged due to language.

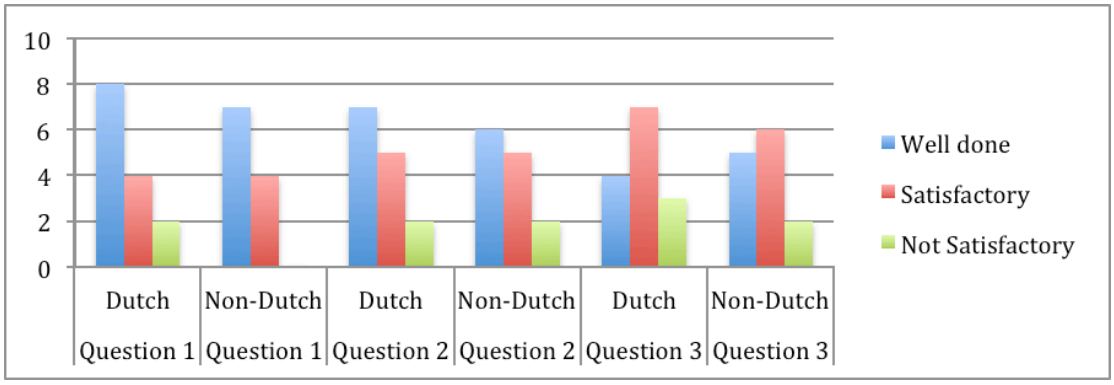

Figure 1. A comparison between the results of the Dutch Learners and Non-Dutch Learners.

d) Validation exercise

As already mentioned the students all agreed that English was their primary language in Maths classes. They agreed that they were far more likely to switch to Dutch at the end of the day when they were tired or when an exercise was particularly difficult or they felt unable to understand what was being asked of them. However they all confirmed that this was always very temporary and they were happy switching back to English. More importantly there was a general agreement that they were more comfortable using English during Maths classes. The reason was that they often only knew the English words for many items of mathematical lexis.

e) Triangulation

The various instruments do support each others' results. The students' perception that they nearly always used English for Maths was confirmed both in the observations and the validation exercise. The accuracy of language use that was observed during the lesson was then backed up by the results of the post task test.

5. Conclusion

Our results are limited in terms of numbers of students studied and the number of hours they were observed. Nonetheless we feel the instruments to have been both a valid and reliable method of analysing language use. Every test of both reliability and validity was successful and the triangulation of the data gave a measure of robustness to the results. This allows us to draw some tentative conclusions about

language use in Mathematics classrooms in this particular context. Firstly, they strongly indicate that the native Dutch speakers in this study use English as the primary language when using the register of Mathematics. The evidence did not support the original hypothesis that learners would code switch regularly into Dutch. Instead, the use of code switching was far less common than anticipated and when used, it almost always worked in reverse of our expectations with learners switching into English for subject specific terms in the middle of Dutch sentences. This rendered our second variable redundant and suggests that, in this context, the learners are either far more comfortable with the English terms or do not in fact know the Dutch ones. Whatever the case it seems that these learners are able to understand and apply Mathematical concepts as well as native speakers of English as confirmed by the results of the post test. However if learners are using English terms because they lack the knowledge in Dutch, these results do suggest that the development of their mother tongue is being neglected.

6. Discussion

Our results do mirror some of the research on code switching from former colonial countries. For example in Kenya (Merrit et al. 1992) and South Africa (Setati and Alder 2000) students were found to use their native languages to discuss difficult mathematical problems and, like the learners in this context, code switched into English for Maths lexis. The authors in these cases explain that the student do this because they have never been taught Mathematical lexis in their own languages. The validation exercise hinted that this might be the case in our classrooms but it would require additional, focused research to verify whether or not this was actually the case. However, unlike the contexts of these studies, there are very few issues of linguistic / cultural imperialism attached to English in the Netherlands. In post colonial countries there is some pressure for teachers to use translation or code switching to establish a more friendly atmosphere or encourage participation (see Arthur 1996 for Botswana, Setati 1998 in South Africa, or Moschkovich 2005 for bilingual latino children in the US). As this motivation is largely absent in Holland it may explain why there is far less code switching.

The potential problem identified by May (2011), Morgan (2007) and Barwell (2007) where learners fail to acquire a sufficient knowledge of the register of Mathematics cannot be applied in this context. However, it is possible that the reverse issue may be true. Namely that within our educational context learners may be developing a strong mathematical register in English at the expense of their native language. The Bilingual Interactive Activation model of lexical processing developed by De Bot et al.(2005) suggests that the more frequently a particular item of vocabulary is activated the more embedded it becomes within a bilingual's language system. If these year 1 students are only learning and using an English mathematical register then this is what will stick in the long term, even if they later encounter the Dutch equivalents.

This is an issue of concern as failure to adequately develop the mother tongue of students goes very much against the philosophy of the International Baccalaureate organisation of which our school is a part. In a recent document (International Baccalaureate 2011) it was stated that it was essential that "*each person has the opportunity to maintain and develop their mother tongue(s)*." The document goes on to link this with the United Nations Convention of the Rights of a Child's assertion that the development of the mother tongue is an essential human right. Furthermore it goes on to state that: "*Multilingual education also improves academic achievement. Increasing learners' literacy in their first language strengthens their academic language development in other languages through the transfer of skills (Cummins 2000).*" Given the potential importance of this issue it adds weight to necessity of undertaking further research in this area.

This necessity is underlined by the relative paucity of data on the effects of bilingual education on the development of students' mother tongues in the Netherlands. For example De Bot et al.'s (2006) research on bilingual education only looked at schools where 50% of subjects were taught through English. Furthermore, in terms of results, they only focused on History and Geography, subjects which do not have the challenging and precise register encountered in Mathematics (Cuevas 1984). In addition, the students in their test groups all reverted to Dutch for the final two years of their study. This is a markedly different

situation from that of our own school where Dutch is the only topic taught in Dutch and learners are taught in English throughout their school careers. Therefore we feel that it would be of some great benefit to collect more extensive data within our own school and would suggest similar studies be done in both other International Schools and potentially in other Dutch Bilingual schools.

7. Consequences and Suggestions for future research

Two practical suggestions for classroom practise in our school have come out of the study:

1) Word lists with translations for all new key words should be put up in the classrooms

2) There should be more cross curricula activities with the language A department to develop a working knowledge of new lexis in both languages.

Within our own school we have suggested that we extend the study. The chief weakness of the research is that it only focuses on one class and one lesson. Our aim is therefore to gain more extensive data. The method we have developed (i.e. a pre survey, observations, tests and post validation exercises) seems robust so we would continue to use it. We envisage the following stages:

1. Firstly to check the reliability of our results we would like to perform a further study in the same year group but with different mathematical problems. In this instance a pre survey is probably not necessary as the students have already done it twice.

2. Studies of other subjects, which have similar specific registers such as physics and chemistry. Again if we remain with the same year 1 class then a pre survey is not necessary.

3. To carry out studies in different year groups. Depending on time and resources we would research language use in all or some of the other years to check if this pattern of language use remains constant across age groups.

4. Finally if the results found in this paper (i.e. that English is almost exclusively used for subject specific register) hold true across both other subjects (with subject specific registers like physics) and in other age groups we could then look at the kind of language proficiency study carried out by De Bot et al. (2006). However in this instance we would be focusing on students' Dutch language skills, and in particular on their ability to both understand and use subject specific register and concepts. The focus of such a study would probably be on the upper years of the school as their language registered are more developed and it would be these students who might potentially be disadvantaged should they choose to go on and study at a Dutch university.

The study has already had an impact. After presenting these results and discussing them with the school management it has been decided to use a pilot program in Grade 7 (first year in secondary education) in the new school year. This class will be split in two streams; a bilingual one which will include students with strong Dutch language background and an international stream. The international stream will be fully taught in English and the bilingual stream partially in English and partially in Dutch. The teaching will be mainly in Dutch and the teacher will occasionally mention mathematical terms in English so the students get familiar with them. The material given to students will be English because then both streams can follow the same curriculum without any discrepancies and avoiding inaccurate translations. Another long-term project might be to track the language use and development of the students on the pilot and compare it to that of students who have only had English language instruction.

8. Reflection

We found that the most difficult part of the process was the initial search for an appropriate area of research. Unlike the other students we had to come up with this ourselves, although obviously with the support of our school. Although by November we had the rather vague topic of looking into language use in Mathematics' classrooms narrowing down the topic into workable research questions took longer than we anticipated. In our initial planning we had hoped to begin our data collection in January or, at the latest February. However it wasn't until

March that our theoretical background and questions were ready. Furthermore we then had to develop suitable instruments so by the time we began, it was late March/early April. We feel that we rather underestimated the difficulties and time required for this part of the study, although this can at least partly be explained by our combined inexperience in social science research. The result was that the quantity of data we collected was less than would be desirable for a more complete and convincing study. We were lucky in that our various instruments gave us results that effectively triangulated and supported each other. If this had not been the case, it is unlikely that the research would have been able to hazard much in the way of concrete conclusions.

Our biggest lesson is therefore to factor in additional time at the beginning for formulating an effective research question and developing suitable instruments. I also believe that more meetings at school (with mentors/management) would have been useful in developing our focus earlier on. Our approach was largely to develop ideas ourselves and more consultation would have been very useful.

In terms of what went well we did work very well as a team. From an early stage we effectively divided tasks met regularly and reviewed each other's work. We set up a shared dropbox folder and would always communicate when there were updates. Our internal feedback was very useful and honest. We believe our instruments were effective, based on suitable theory and delivered what we hoped for. It is true that we underestimated the amount of time needed to code and catagorise the observed lessons and this would definitely need to be taken into account in the planning of any similar research in the future. Nonetheless for a group with no prior background in this type of research we feel we developed a great deal, in a short period of time, in terms of our knowledge and skills in this area.

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