LANGUAGE SWITCHING WITH A GROUP OF BILINGUAL STUDENTS IN A MATHEMATICS CLASSROOM

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This paper presents a report on how a group of immigrant bilingual students use their languages in the learning of mathematics. We have developed our research with immigrant bilinguals in Catalonia, Spain, that arrived at a young age from South-American countries. We propose a critical sociolinguistic approach, which draws on social theory in the analysis of how language is involved in the construction of teaching and learning opportunities. Our data points to the differences that the Spanish dominant bilingual students have in the use of Catalan and Spanish during their engagement in mathematical activity. They tend to use the two languages for different purposes, depending on the complexity of the mathematical practices, and in relation to different social settings that coexist within the classroom.

INTRODUCTION

A majority of students in immigrant bilingual mathematics classrooms in Catalonia, have Spanish as a first language, however, they learn mathematics in Catalan, the official language of learning and teaching mathematics. How do these Spanish dominant bilingual students use languages during mathematics teaching and learning? Do they switch languages during mathematical activity? If so, what are some of the factors that seem to promote their language switching within the context of specific lessons? In this paper we explore the above questions by drawing on a wider study involving immigrant bilingual children that were either born in Catalonia or went there at a young age from South-American countries and attended a Catalan school. We discuss two of the most recurrent themes in the data: 1) the acquisition of specific vocabulary in the second language; and 2) the development of mathematical argumentations in the first language.

By studying bilingual learners, we hope to come to a better understanding of how the use of the languages is mediated by the interpretation of the different contexts of mathematical school practices. Although many researchers recognize that the choice of language in bilinguals may vary depending on where and how the language is used (Daller, Van Hout & Treffers-Daller, 2003), we still have to further develop research on this topic in the case of contexts of mathematical practices.

A SOCIOLINGUISTIC APPROACH TO BILINGUISM

In this study we propose a critical sociolinguistic approach, which draws on social theory in the analysis of how language is involved in the construction of teaching and learning opportunities. We consider the construction and use of the language.

essentially as a social process embedded in social interaction that takes place in social participation structures where issues of identity and power are structural. This process of construction and use of language is about how individuals, groups and the contexts mutually constitute one another and work to maintain certain power relationships and change others. Our approach is influenced by the perspectives of several researchers on mathematical learning and multilingualism such as Barwell (2005), Clarkson (2007), Moschovkovich (2007), and Setati (2005). These authors assume the integrity of the language and culture of minority groups, and emphasize the need for developing a sense of “language awareness” in the domain of mathematics education research. They have in common: a) the attention to the on-going struggles over power, and resulting inequalities, in multilingual contexts of mathematical practice; b) the analysis of both social structure and agency; c) the need for sociolinguistic work to draw on social theory in our understanding of school mathematics; and d) the interest in how difference and dominance may be created in face-to-face classroom interactions.

The phenomena of language contact and linguistic diversity are particularly represented by bilinguism, in relation to the knowledge of and the ability to use two languages. In our work, a bilingual is someone who has learned to understand and speak the world by means of two languages, although the understanding may not be the same depending on the language that is being used. We focus on how bifinguals integrate the diversity of understandings, and how they put together their knowledge of two languages to use in communication. The integration of languages and the construction of joint knowledge are always problematic as language contact involves one kind or another of social imbalance that reflect tensions among groups. The selection of one language as well as the maintenance or the eventual shift to the other, are types of imbalance that are related to the differences in the knowledge of the languages, and to the social contexts where the languages are used. Caldas and Caron-Caldas (2002) argue that a bilingual’s preference for either of her/his two languages is context sensitive: the shift to the language with a higher status may be favoured by the students’ perception of conditions of gaining access to social goods, while the maintenance of the language with a lower status may be associated to the perception of conditions of segregation and marginalization.

CONTEXT AND METHOD
Catalan is a Romanic language that shares many linguistic structural properties with Spanish. These structural similarities distinguish this research from studies on immigrant bilinguais in Europe that are faced with the problem of comparing the use of language pairs with large structural differences, such as Norwegian and Turkish or Arabic. While Catalan and Spanish are both common street languages in Catalonia, Catalan is the official language of teaching and learning. This means that teachers are required to produce written texts in Catalan and to use Catalan in their oral talk.
The main data for this study came from regular lessons in a secondary school bilingual class in Barcelona, Spain, with twenty-four students about twelve years old and an experienced bilingual Catalan native speaker teacher. Data was collected over five consecutive lessons of fifty minutes each. The lessons were planned for the students to spend time working in small groups. The goals in the class included giving the students the experience of “thinking like mathematicians” and “learning basic facts about the mathematics”. Students had been informed that they were expected to “develop some ability to think critically about mathematics in open-ended situations”. For the five lessons that were video-recorded, the contents were related to geometrical transformations. The unit, “Our dynamic planet”, included a variety of mathematical activities that were thought as a way to allow students to pose questions and solve problems in real contexts. In the third lesson, the students were asked to mathematically represent a tornado.

In the class, there were eight students from South-America who were Spanish dominant bilingual, whereas the other sixteen students from Catalonia, mostly from Barcelona, were Catalan dominant bilingual, except for one of them who was a second generation immigrant and came from a Colombian family. All the students had a different bilingual proficiency profile due to the differences in their biographies. Although they were not “balanced bilinguals”, most of them could be seen as almost native-like competent in their second language. They all had similar working class backgrounds; most of their parents had not completed high school, were limited Catalan proficient and immigrated to Catalonia for work reasons. Our research was focused on the nine students who spoke Spanish at home. The data for this report comes from one of the regular small groups (WG1), whose members were Máximo (M) –a second generation Colombian boy–, Luna (L) –a girl born in Peru– and Nicolás (N) and Eliseo (E) –two boys born in Colombia. The teacher described the four students in this group as having an average mathematical competency.

For the five class periods, the teacher and one of the students in each group wore a wireless microphone. There was also a static camera placed in one corner to capture the general picture of the entire classroom environment. For the analysis, different portions of the students’ interactions within the small groups and with the teacher were first isolated and then transcribed. After having examined that language switching occurred, by quantifying the shifts from Catalan to Spanish and from Spanish to Catalan, we drew on ethnomethodology and interactional sociolinguistics to describe the contents of the talk that were observable and interpretable when reading the interactions. The use of a constant comparative method led to the development of interrelated themes that seemed to be promoting language switching.

RESULTS
Our data points to differences in the use of the languages during the Spanish dominant bilingual students’ engagement in mathematical activity. When the students
are getting familiar with the task and the new mathematical vocabulary, they tend to use Catalan, both with their small group peers, who are Spanish dominant, and with the teacher. However, when they start reflecting on the resolution of the task, they tend to use Spanish as if it was easier for them to complete and communicate their mathematical processes in this language. The experience of searching for mathematical explanations seems to be a factor that initiates students’ switching between languages. We know about this type of findings in relation to English as a second language and with pairs of languages that have many structural linguistic differences such as Vietnamese and English or Iranian and English. But there is not literature regarding language switching by Catalan and Spanish bilingual students in Catalan mathematics classrooms. The language context given by the socio-political situation in our country, where Spanish has a low social standing, makes it relevant to pay attention to the particularities of this group of bilingual students and their efforts towards the public use of Catalan, the language with a higher status.

**The acquisition of specific vocabulary in the second language**

In the five lessons, during the first minutes the teacher gives priority to the introduction of mathematical vocabulary concerning geometry. She asks the students if they know the meaning of a certain word that has been written on the board or orally introduced, and urges them to use it in the context of the task. She does not translate the word into Spanish neither do the students ask for a translation. She begins by only explaining vaguely the mathematical meaning of the new word and leaves the students to explore in small groups the underlying concepts in the context of the task. In the interactions with the teacher, the immigrant students tend to use Catalan, their less proficient language, when they are prompted to introduce new terms. The following two excerpts from the third lesson are entirely in Catalan. The first excerpt shows part of the moment when the words “helicoidal”, “helicoid” and “helix” are presented. Particularly interesting here is the way in which the speakers co-learn individual vocabulary terms by repeating one another’s talk, completing the other’s turns and providing supportive feedback. The teacher (T) models language behavior by only using the Catalan and suggesting the idea of “word family”:

**T**: Sabeu què és un moviment helicoidal? / Do you know what a helicoidal motion is?

**M**: Bé, sabem el que és un tornado. / Well, we know what a tornado is.

**N**: I sabem que un tornado es mou amb facilitat i rapidesa. / And we know that a tornado moves easily and quickly.

**T**: Un tornado va recte endavant i també gira. És un moviment helicoidal. / A tornado goes straight forward and it also turns around. This is a helicoidal motion.

**M**: Un tornado va recte i cap avall. Com es diu? Helicoidal? / A tornado goes straight forward and down. How do you say it? Helicoidal?

**T**: Es diu igual. Un moviment helicoidal. Una helicoïde. Una hèlix. És el mateix. / You say it the same. A helicoidal motion. A helicoid. A helix. It is the same.
In the interactions with the Spanish dominant students in the small group initial discussions, the immigrant bilinguals also tend to use Catalan. They go on with the use of Catalan in the context of getting familiar with the new words when talking to their peers, even when the teacher is not standing next to them. In the excerpt below, they do not accept incorporating the word “spiral”, which does not fit into the helicoid’s word family but could be seen, however, as part of a “concept family”. Both the helicoid and the spiral have in common the idea of representing a curve in motion and some of the shared geometrical meanings associated to these words are helpful in the representation of a tornado. Eliseo points to the idea that the understanding of the concept “tornado” is more important than the words we use for it, but then rejects talking about spirals. One can sense in this excerpt possible tensions between the focus on the language and the focus on the mathematics, specifically between the idea of practicing the new vocabulary (“We are talking about helixes, not spirals”) and the idea of exploring geometrically similar mathematical concepts (“It is a bit of a spiral”). All the utterances were in Catalan except for the last one, below we only reproduce the English translation in order to reduce the length.

L: We need to make the spiral.
N: Not a spiral, a helicoid, a helix.
E: What we really need to make is a tornado. And we need to name it a helicoid.
L: Do we need to make the arrows like yesterday?
E: We need to understand what a tornado is and then we find a name for it.
N: But now they are arrows of a helicoidal motion. It is a bit of a spiral.
E: We are talking about helixes, not spirals.
L: We are talking about helicoidal arrows.
M: We need to decide the arrows that we draw and that’s all.
E: First we think about the arrows, then we draw them and then we talk about it.
M: [Spanish] This idea of the arrows is not easy. We have to imagine the different movements that exist within the tornado.

Máximo uses Catalan when reproducing the new terms and changes to Spanish when starting to develop more sophisticated arguments based on the coexistence of different simple motions within a helicoid. The students’ initial interactions around the notion of helicoid are centered on how this notion is represented in the context of the task and in relation to the teacher’s language priorities. They give priority to the use of the new words (a word family) instead of making distinctions or stating similarities between a spiral and a helicoid (a concept family). In the next section, we show that, in general,
the students’ switching in the middle of certain conversations seems to be sensitive to the type of practices. They tend to switch from Catalan—when “getting familiar with the new vocabulary”—to Spanish—when “solving the task”—and maintain the switch to Spanish during the time devoted to argumentation in the small group.

The development of mathematical argumentations in the first language

The excerpts above show how well particular mathematical vocabulary is used in the context of the Catalan language but do not give information concerning which of the mathematical meanings for the new words (“helicoidal”, “helicoid” and “helix”) are known, neither do they inform about the process of further exploring some of the geometrical concepts that are being represented by these words. The Spanish dominant students go back to their first language in the small group when they start experiencing some difficulties in the process of resolution and when they try to complete their explanations and, more generally, the mathematical task. This is the case with WG1 in the third lesson. Below, we reproduce the English translation of a conversation that happens entirely in Spanish:

N: It can be a diagonal arrow.
L: But the tornado does not follow a diagonal direction, it goes down and turns around at the same time.
M: The helicoid is like a broken arrow [he makes the drawing on the left in Figure 1].
E: A tornado is much more complicated. I will do it like this [the drawing on the right].
L: I don’t think that a tornado may be represented with arrows. When you look at it, it doesn’t go by staggering, now this direction and then the other.
N: None of your drawings are real. A tornado moves like a circle and you have only made rectilinear lines.
E: Now it does make sense to talk about the spiral.

Figure 1. Some of the students’ drawings representing a tornado.

The following excerpt starts with Luna asking for help in Spanish (S). Nicolás goes back to Catalan (C) and points to some key terms for the understanding of the task. As soon as Luna shows to have understood the meaning of the key words in the context of the task, Nicolás goes on with the mathematical explanations of the arrows in Figure 1 and uses again Spanish. Eliseo insists on introducing the notion of spiral, which is now accepted, probably because now it is not seen as an obstacle in the learning of new vocabulary. The references to the curves of a spiral will help to complete the linear representations in Figure 1 with curves (see Figure 2). It is interesting to note that while the approach to the task seems to be centered on the
learning of a word family, the notion of spiral is not accepted and the idea of curvilinear lines is not considered. Later, when the approach seems to be centered on the learning of the mathematics, the consideration of the notion of spiral is allowed and a more accurate representation of a tornado is achieved.

L: [S] The question asks to represent a tornado, doesn’t it?
N: [C] Yes, it says that we need to mathematically represent a tornado.
L: [C] It’s not to talk about a tornado, it is to mathematically represent it.
E: [S] The drawing of a tornado can be useful before its representation.
N: [S] It is clear that only one arrow is not enough, a tornado is more than a translation.
E: [S] We need to think about the drawing of a spiral. We would draw curves.

These four immigrant bilinguals use their two languages for different purposes. They use Catalan when getting familiar with new vocabulary, when situating the use of this vocabulary in the context of the given task, and when beginning to organize approaches to the resolution of the task. However, they use Spanish, their dominant language and the language that they share with their small group peers, when arguing at various degrees of specificity and developing more complex comprehension processes that are not centered on the repetition of some of the teacher’s words and sentences. Our findings, concerning the use of the first language when elaborating on an argumentation, fit with Moschkovich’s data (2007) where Latino students use Spanish to justify an answer or elaborate on an explanation and return to English when being asked by the teacher to give priority to the acquisition of new vocabulary.

The data from the whole group interactions in the five lessons shows that the group of Máximo tends not to speak when the teacher asks the groups to present their reasoning. Their engagement with the mathematics in Spanish does not lead to an increased participation in Catalan outside the context of the small group, although they are allowed to use the Spanish language. On the few occasions that the teacher asks these students to interact, they make short interactions in Catalan. Conversely, the local bilingual students tend to volunteer information unprompted, even interrupting the teacher to do so.

FINAL REMARKS
We have illustrated data concerning the use of the two languages by a group of bilingual students. These students tend to use each of the two languages in different domains of mathematical practices (acquiring vocabulary vs. explaining and arguing), and in relation to different social settings within the classroom (small group vs. whole
group). First, when the Spanish dominant bilinguals in our study are prompted by the teacher to get familiar with the task within their small group and learn new mathematical vocabulary, they change to Catalan, which is the language in which this vocabulary is introduced. Second, when these students go more deeply into the resolution of the task within their small group, they change to Spanish although eventually they may go back to Catalan for certain clarifications. Third, when the time for the whole group discussion starts, they only intervene if they are directly asked by the teacher to do so and, when this happens, they use Catalan. For a further interpretation of this sort of language switching, we need to frame it in terms of the students’ expectations about what they might achieve—or lose—by speaking in one of the two languages, given their different levels of language and mathematical proficiency and the role of each language within that classroom.

References


