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(2021) Students' oral communication in the high school French immersion mathematics classroom

How do students communicate when working together on problem-solving tasks in the high school French immersion mathematics classroom?

Introduction

Over the years, several large-scale research studies (e.g., Cummins & Swain, 1986; Day & Shapson, 1996; Swain & Lapkin, 1982; Turnbull et al., 2001, 2003) have examined student achievement in French immersion mathematics in the Canadian context. While student achievement is not a simple, straightforward matter, it is useful to

note that, overall, the results of these studies spanning several decades suggest that French immersion students were not disadvantaged when compared to their peers in English-only programs and in some cases outperformed these peers on mathematics assessments. French immersion students enrolled in early entry total immersion programs tended to perform particularly well; and whereas students enrolled in late entry and/or partial programs sometimes did not perform as well as their English-program peers, this lag usually resolved itself in the long term.

Less research has been done exploring what happens during the daily interactions of the French immersion mathematics classroom, especially at the high school level. The interactions that occur in bilingual mathematics classrooms have become increasingly of interest not only to second language educators but also mathematics educators. Indeed, a number of mathematics education scholars have identified a need for more research about language in the mathematics classroom and especially in the bilingual mathematics classroom (Morgan et al., 2014).

To this end, this 2017 doctoral study explored students' oral communication in a high school French immersion mathematics classroom. A total of 22 grade 9 participants across two different classes worked collaboratively in pairs or small groups on a problem-solving task, which was guided by a series of written instructions and included questions to answer in written form. The students were audio recorded over the course of three class periods of 55 minutes each as they worked together on the task. Their interactions were transcribed and then analyzed through a sociocultural theory lens (e.g., Vygotsky, 1978), using discourse analysis methodology (Gee, 2014). This research brief presents some of the key findings from the study, especially as they relate to implications for the French immersion mathematics classroom.

Question 1 : Why is communication important in high school French immersion mathematics?

Mathematics is sometimes considered to be a school subject that is made up strictly of symbols, numbers, and right-or-wrong answers

to procedural questions. And skills and procedures are indeed an important part of knowing how to "do" mathematics. In this view of mathematics, language does not seem to play an important role. However, school-based mathematics involves more than procedural knowledge. It also requires mathematics concept knowledge and perhaps most importantly, concept understanding, moving students beyond memorization of procedures and algorithms. In order for students to make sense of mathematics concepts, language can be an important tool. The National Council of Teachers of Mathematics (NCTM, 2000) cites "communication," which involves a great deal of language, as one of five essential processes that are key to learning mathematics with understanding. In French immersion, communication occurs (mainly) in the target language (i.e., French), which provides much-needed opportunity for students to negotiate meaning (receiving input, producing output), especially when they engage in collaborative dialogue (Long, 2007; Swain, 2000). Thus, the French immersion mathematics classroom is a most appropriate space in which to promote communication, as communication is fundamental to both mathematics understanding and language acquisition.

Question 2 : What does mathematical communication look and sound like?

Scholars of linguistics (e.g., Halliday, 1978) and mathematics education (e.g., Pimm, 1987) have pointed out that within a given language (e.g., French) there is a *mathematics register*, that is, there are special words, structures, and meanings that are appropriate for the particular function of mathematics. In other words, the mathematics register is the language used to do and make sense of mathematics. Beyond that, other mathematics education scholars, particularly some who study mathematics in bilingual education settings (e.g., Moschkovich, 2007; see also Barwell, 2007; Culligan, 2017), have suggested that there is a specialized language of school mathematics. This *mathematics education register* comprises the mathematics register and the register of the classroom. When

viewed through this lens, mathematical communication in school involves not just the use of textbook-academic language such as mathematics vocabulary terms and sentence structures (although these are an important part of mathematical communication), but also meaning-making mathematical ways of talking such as being precise, abstracting, making connections, representing, and reasoning. This communication is often characterized by the use of "everyday" or informal language in mathematical ways, mixed together with more standard academic language. This shifting, contextualized, socialized view of mathematics allows an expanded vision of what "counts" as mathematical communication. It is this view of mathematical communication that guided the analysis of the students' talk in this research study.

Question 3: What types of problems are more likely to generate communication in high school French immersion mathematics?

As Fisher et al. (2008) have reported, mathematics classrooms at the secondary level have traditionally been dominated by teacher talk. The authors have pointed out that research studies over the years (from the 1970s through the 2000s) have shown that this is especially the case in classrooms with higher numbers of students living in poverty, and higher numbers of lower achieving students, with one such study having found that teachers speak anywhere from 55% of the time (in classrooms with higher achieving students) to 80% of the time (in classrooms with lower achieving students). Within this large quantity of teacher talk, the discourse mainly consists of teacher-initiated comprehension check questions rather than rich interaction that is more effective at promoting critical thinking and a deeper conceptual understanding of the material. Thus, despite curricular reforms and more recent pedagogical approaches to mathematics teaching that encourage student communication, teachers must continue to be deliberate about fostering student talk in the mathematics classroom. Collaborative tasks, for example, are part of a model of more purposeful student talk, and provide

opportunity for students to work together, largely independent of the teacher, while using language to negotiate meaning and critically engage with the mathematics material (Fisther et al.). Students in French immersion are expected to communicate in their second language, which adds an additional layer to which teachers must attend.

Mathematically and linguistically rich communication can be supported by giving students the opportunity to interact while working collaboratively on problem-solving tasks. From a mathematics standpoint, in order for students to reap the potential benefits of communication, such as deeper conceptual understanding, they first need to be motivated to communicate. From a language standpoint, in order for students to be motivated to use language in meaningful ways they first need to have something about which to communicate. In this study, it became apparent that choosing problem-solving tasks that adhere to a number of the key features of good quality, worthwhile mathematics problems served to increase the level (both quantity and quality) of student talk in the classroom. The NCTM (2010) has identified at least 10 criteria for teachers to consider when choosing a mathematics problem-solving task. The task chosen for this study met at least the following of those criteria: it had important, useful mathematics embedded in it; it contributed to the conceptual development of students; it could be approached by students in multiple ways using different solution strategies; and it encouraged student engagement and discourse. The task related to curriculum outcomes in geometry, measurement, and number operations, with a low-tech, hands on component that involved modelling and scale drawings. The problem-solving activity resulted in student talk accounting for a range of 83.5–98.4% of the total classroom talk. Among the groups a range of 68.3–100.0% of talk was considered to be “on task” (although it is difficult to clearly judge what consists of “off task” talk, especially when adopting a broader view of what counts as mathematical communication). Students were thus able to spend an extended period of time engaging with important mathematics while using contextualized, purposeful language. It is worth noting that although many students in this study expressed a positive reaction to the task, not all of them did. As always, using a variety of pedagogical

strategies and problems over the course of the school term is important when it comes to reaching all learners.

Question 4: How do students communicate during a collaborative problem-solving task in high school French immersion mathematics?

As students talked through the mathematics problem-solving task, they attended to language, mathematics, and the management of the task itself.

This study analyzed students' communication in a way that was inspired by the approach taken in Swain and Lapkin's (1998, 2000) studies, which looked at "language-related episodes"—instances in which students talk about the language they are using, question their language use, or correct themselves or others—as students worked together on second-language tasks. Although students in this study collaborated on a mathematics problem-solving task, their discussions still contained language-related episodes in which they made meaning by attending to vocabulary, including academic-mathematical vocabulary (e.g., scale/*échelle*, area/*aire*) as well as everyday vocabulary (e.g., narrow/*étroit*, paperclip/*trombone*) used in mathematical ways or often to move the task along. Students also corrected or provided alternatives to either their own or others' language choices. Many of the students' language-related episodes occurred when it was time to write their answers.

Inspired by mathematics education studies based in various bilingual contexts (Barwell, 2007; Moschkovich, 2007) as well as the language-related episodes concept, this study also looked at "mathematics-related episodes," instances in which students communicated about the mathematics at hand (Culligan, 2017). Some of the students' most common mathematics-related episodes involved describing a mathematical situation and, by far the most prevalent, expanding on an explanation by elaborating (repeating or

restating), extending (adding or replacing), or enhancing (time, place, or cause).

During these communication acts, the French immersion students used their first language (English for all participants in this study) to varying degrees. Two participant pairs/groups had a low percentage of French utterances, speaking French 22.5% and 6.3% of the time respectively. However, these two groups were outliers when compared to the remaining seven pairs/groups, who spoke French anywhere from 56.0–95.5% of the time. English was used mostly for vocabulary searches; when the "cognitive load" got heavy (i.e., when students were talking through something difficult related either to mathematics or language or both); for task management (e.g., equipment management, following steps/instructions); or for interpersonal interactions (e.g., vernacular, expressing humour or feelings, disagreements).

Overall, language-related episodes and mathematics-related episodes often co-occurred, with the mathematics problem providing the context within which students communicated using (mainly) the target language.

Implications for classroom practice:

Teaching French immersion mathematics requires teachers to adopt a dual role: mathematics teacher and language teacher. By viewing communication as an integral part of learning mathematics with understanding, teachers can find ways to support mathematics and language learning in a cohesive, integrated fashion, rather than approaching these as separate endeavours. Teachers can foster opportunities for students to engage in important language-related and mathematics-related episodes by allowing students time and opportunity to work on problem-solving tasks independently, ideally in pairs or small groups; choosing good problems; providing intentional scaffolds as needed; asking questions that require students to provide explanations of mathematical situations; incorporating a written component or other type of final product into the task; and being open-minded about what "counts" as

mathematical communication. Strategies such as beginning lessons with a problem-solving task and having students work in small groups with their own whiteboards (or other type of temporary vertical surface) have been shown to be among the most effective and least difficult ways in which teachers can begin fostering the conditions for problem solving in their classrooms (e.g., Liljedahl, 2016).

High school French immersion mathematics students have a wide range of mathematical and linguistic resources to bring to the classroom. In a bilingual classroom, such as French immersion, teachers should also expect students might use their first language(s) to some degree when engaged in prolonged communicative tasks. To navigate this tension between the classroom reality and the target-language-only policy that often defines French immersion programs, teachers could choose to accept some use of students' first language by viewing it as only one small part of their entire communicative repertoire, especially if it is used judiciously and with mathematical or linguistic purpose. Thinking of first language use as part of *translanguaging* (e.g., Garcia & Wei, 2014), which considers how bilingual learners in various contexts use not only their different languages but also other resources in order to communicate, could make space for discussions about how to approach communication in French immersion mathematics moving forward.

Conclusion

For teachers who want to support student communication in the French immersion mathematics classroom, embracing the intertwined nature of mathematics and language and keeping a broad view of what constitutes mathematical communication are key. By choosing good problems, among other sound pedagogical practices, teachers can foster conditions in which students are motivated to communicate while attending to mathematics and language, gaining a deeper understanding of both.

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