MATHEMATICS AND LANGUAGE INTEGRATION IN A CLIL CLASSROOM: AN ANALYSIS OF GENRE

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Teachers in mathematics classrooms where the language of instruction differs from students' first language face competing demands regarding mathematics and language teaching. In this study, I conducted an analysis of genre of teaching episodes to examine how a teacher in a Spanish immersion third-grade classroom in the US responded to those demands. Findings indicate that the genres on which the teacher drew are associated with mathematics and with language classrooms, in addition to general genres that can be found in either classroom. I argue that the teacher's awareness of school demands and of students' needs influenced how genre-switching unfolded. I discuss how genre analysis adds to conceptualisations of mathematics and language as integrated in CLIL classrooms.

Keywords: Equity and Diversity, Instructional activities and practices

Mathematics teachers face competing demands in classrooms where the language of instruction differs from students' first language.[1] Teachers have the double responsibility of supporting students' development of mathematics and the additional language (Nikula, Dalton-Puffer, Llinares, & Lorenzo, 2016). These teachers confront the decision of how to split class time between these two competing demands. An alternative is to approach mathematics and the additional language as integrated. Integration is the premise of Content and Language Integrated Learning, CLIL, frameworks (Nikula et al., 2016). In CLIL classrooms, the language of instruction differs from students' first language[1]. Rather than regarding the role of the teacher as complying with competing content and language demands, CLIL teachers integrate the two.

In this study, I draw on the concept of genre to consider the role that societal forces play in mathematics CLIL classroom interactions. I follow Bakhtin's (1986) notion of genre that considers both linguistic and social influences on interactions. I propose a view of classroom episodes as representing teaching genres that are particular to mathematics or to language classrooms. I ask the following research question: How does a teacher in a CLIL classroom integrate mathematics and foreign language to respond to competing demands? I argue that a dialogic dynamic among language, content, students' needs and school demands drove the teacher's efforts toward integration. Both individual and school orientations toward mathematics and the foreign language influenced how integration unfolded.

This paper relates to the theme of the conference of celebrating 40 years of PME-NA. The paper focuses on one of the enduring challenges in mathematics education research that the conference addresses: supporting *all* students through equitable teaching informed by bodies of knowledge that the conference has supported. Specifically, the paper sheds light on the role

[1] Following Johnson & Johnson's (1999) definitions, I refer to **first language** as the language to which a person is exposed from birth and in which the person is raised. A **second language** refers to a language other than the first language that is widely used in the person's community (for example, English is a second language for Spanish speakers living in the US). A **foreign language** is a language other than the first language and that is not widely used in a person's community. An **additional language** encompasses all languages other than a person's first language.

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teachers play in mediating competing demands in mathematics classrooms where the language of instruction is different from students' native language.

Theoretical Framework

Mathematics and Language

I draw on a perspective that regards mathematics and language as integrated and inseparable. Instead of delimiting where mathematics ends and where language begins, this perspective defines the two as an entanglement. Rather than a final representation of an already existing idea, language is part of developing, communicating and refining mathematical ideas (Barwell & Pimm, 2016). Accordingly, mathematics and the additional language develop in tandem. Mathematical activity involves continuous learning and relearning the additional language as it emerges in interaction (Brown, 2002). Additionally, using particular languages influences mathematical activity. For example, certain languages express particular mathematical concepts in a more transparent way than other languages (Martínez, 2018). Teachers may draw on the language that more transparently represents a mathematical idea if such language is valued at school. The intersection between a language and mathematical activity presents particular complexities, including the social orientations about what languages to use in academic settings.

CLIL in Mathematics

I draw on definitions of CLIL as an umbrella term that refers to classrooms where students learn both content and an additional language (Nikula et al., 2016). CLIL classrooms have both content and language goals and expectations. The focus of CLIL, however, is on integration: "[CLIL's] distinctiveness lies in an integrated approach, where both language and content are conceptualised on a continuum without an implied preference for either" (Coyle, 2007, p. 545). Because of this attention to integration, CLIL is consistent with this study's purpose of exploring how a teacher integrates language and content to respond to competing demands.

In addition to the focus on integration, CLIL highlights that contextual forces influence classroom interactions. The purpose of CLIL pedagogies is not exclusively to bring a set of pre-existing grammar structures to the mathematics classroom. Instead, CLIL draws attention to how expectations about language, mathematics and schooling affect pedagogical decisions: "CLIL teaching [is] a site where diverse institutional, educational, personal and pedagogical scripts and purposes intersect" (Nikula et al., 2016, p. 27).

Genre Analysis

I follow a Bakhtinian definition of genre as a socially discernible type of language use (Bakhtin, 1986). Rather than being classifications that specialist linguists propose, genres are sets of cultural conventions (Gerofsky, 1999). That is, genres are what a collective believes them to be and they are influenced by the ideologies, expectations and histories of a specific culture (Gerofsky, 1999). This simultaneous attention to language use and social influences is consistent with this study's purpose of exploring a mathematics CLIL classroom in light of institutional and societal expectations and demands. I build on research on genre that is consistent with a perspective of mathematics and language as integrated. These studies attend to both linguistic features and social orientations and demands that influence language use. For example, when studying lectures as a genre in mathematics education, Gerofsky (1999) drew attention to linguistic features such as the non-inclusive we/us, ambiguous use of nouns, and saturation of imperative forms. Simultaneously, he regarded social expectations for the interaction as constitutive of the genre, including who is supposed to be silent and who is expected to speak.

For the purpose of this study of exploring how a CLIL teacher integrated mathematics and language to respond to competing demands, I focus on genres as teaching episodes associated

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with language or mathematics classrooms, as well as general genres associated with multiple classrooms. Particular types of language use, and teachers' and students' actions can be thought of as typical of language teaching or mathematics teaching. Different genres respond to specific institutional and social demands, with some genres motivated by demands about language acquisition and others motivated by demands about mathematics learning. Drawing on different genres throughout a lesson and a unit, teachers respond to competing demands: "The focus would be on the different intended and perceived purposes embedded in different genres, and on a mastery and enjoyment of genre-switching" (Gerofsky, 1999). This approach acknowledges social influences in recognising and using language at the level of classroom interactions.

Methodology

Sites and Participants

This elementary school was located in the Midwest region of the United States in a mostly White, middle class, English monolingual community. The school offered a Spanish language immersion program. Following a language enrichment full immersion model, all instruction was in Spanish, except for one hour taught in English per day. Mathematics was taught in Spanish. The classroom was a third grade with nine female students (one Latina, one African American, seven White) and 14 male students (two African American, 12 White). All students spoke English at home. All 23 students were able to comfortably initiate and sustain a conversation in Spanish. The teacher, señora Abad (all names are pseudonyms) was a US-born Latina who considered both English and Spanish her native languages. Her educational background was in Spanish bilingual education. She had been a teacher for three years.

Data Generation

I used ethnographic methods (participant observation, interviews and field notes) to generate data on how the teacher integrated language and mathematics and how such integration related to competing demands external to the classroom. Consistent with this study's purpose of illustrating how the teacher drew on different genres rather than claiming this is an exhaustive list, I focus on one geometry unit. I chose this unit because it took place toward the end of the academic year when patterns of interaction were stable. I video recorded three lessons per week which resulted in nearly 11 hours of video for 12 lessons. I transcribed all video recorded lessons. Throughout the unit, I conducted unstructured interviews where the teacher and I discussed preliminary findings, confirming or redirecting my analyses. I documented references to forces external to the classroom that influenced the lesson, including the teacher's references to the pacing guidelines, communications with parents, the textbook, and assessment. I transcribed interviews.

Data Analysis

Analysis focused on video data and interview data supported interpretations. The unit of analysis were teaching episodes which I defined as class moments beginning with a change in topic, task or teaching method. The 12 lessons in this unit resulted in 85 teaching episodes. Consistent with the discussion of genre above, during a first stage of analysis I examined both linguistic features and social conventions in each episode. Drawing on Gerofsky's (1999) tools to analyse genre, I annotated the following dimensions in each teaching episode: who influenced the direction of the conversation, modes of communication (written, spoken, gestures), types of questions asked and who asked them, resources being used (for example, textbooks and manipulatives), who addressed who (teacher-student, teacher-whole class, student-student), mathematical content, mathematical practices (for example, giving an answer and describing a problem solving strategy), languages being used, and the level of attention to language accuracy.

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During a second stage of analysis, I looked for patterns across transcript annotations. I grouped similar episodes and characterised each group. I conducted this process three times, refining classifications and interpretations, resulting in 11 teaching genres. During the third stage of analysis, I classified each genre as associated with language or with mathematics teaching, or as general. This classification corresponds to the focus of the episode, the teacher intentions as expressed in interviews, and my interpretation of whether the observed episode was recognizable as typical of mathematics or language classrooms or both.

Findings

Analysis revealed that the teacher drew intermittently on clearly discernible mathematics and language teaching genres to respond to demands on each of the two areas. Moreover, some of the genres seem to be associated with both mathematics and language classrooms. Table 1 synthesises the distribution of teaching episodes in each genre and genre category.

Table 1. Number of teaching episodes by genre.

Genre Category	Genre	Number of episodes
General	Whole class discussion	21
	Small group task	18
	Task launching	11
	Teacher explanation	8
	Student presentation	4
Language teaching	Info gaps	6
	Artifact description	4
	Role playing	2
Mathematics teaching	Textbook work	6
	Number talk	3
	Test	2
Total number of episodes		85

Due to space restrictions, I focus on the most frequent genre in the language and the mathematics categories. In the transcripts below, text in brackets describes actions.

Mathematics Episodes: Textbook Work

In the textbook work genre, students worked individually or in pairs solving problems from the textbook. One example of this genre took place during the seventh lesson of the unit. Students were working in pair on a page that asked them to find three rectangles with a perimeter of 12 centimetres. Afterwards, students needed to fill out a table with the lengths of the adjacent sides and the area of each rectangle. The teacher told students they could get geoboard dot paper if they wanted to draw their rectangles. A few minutes into the task, Señora Abad approached two students, Lisa and John. They were working in silence and looking at each other's textbook. John had drawn a 2x2 square and Lisa had written 2 and 2 in the first row of the chart and 2 and 4 in the second row. Señora Abad asked the students what the perimeter of their square was. Putting her finger in the middle of the square, Lisa answered that the perimeter was four.

Table 2. Example of the textbook work genre.

Speaker	Original Utterance	Transcribed Utterance

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Señora Abad	El perímetro es afuera.	Perimeter is outside.
Lisa	[Mira el dibujo en silencio.]	[Looks at the drawing quietly.]
John	[Mira a la señora Abad] ¿Estamos sumando o multiplicando?	[Looking at señora Abad] Are we adding or multiplying?
Señora Abad	¿Qué es perímetro? [Mira a Lisa y a John.]	What is perimeter? [Looks at Lisa and John].
Lisa	Afuera.	Outside.
Señora Abad	Afuera. Entonces, ¿qué hago para buscar el perímetro de esta figura?	Outside. So, what do I do to look for this shape's perimeter?
Lisa	Sumar.	Add.
Señora Abad	Mmhm. ¿Qué sumo? [Mira a los dos.]	Mmhm. What do I add? [Looks at both.]
Lisa	Dos mas dos mas dos mas dos.	Two plus two plus two plus two.
Señora Abad	Y eso es…	And that is…
Lisa	¿Ocho?	Eight?
John	[Borra los números 2 y 2 que había escrito en su cuadro.]	[Deletes numbers 2 and 2 that he had written in his table.]
Señora Abad	Ocho. Pero yo necesito rectángulos con un perímetro de doce. Tú me dices que dos y dos te da un perímetro de doce.	Eight. But I need rectangles with a perimeter of twelve. You say from two and two you get a perimeter of twelve.
Lisa	No.	No.
Señora Abad	OK. Puedes usar tu cuadrícula de puntos [señala al papel de John.] Aquí en esta [señalando a la segunda fila del cuadro en el libro] tú me estás diciendo que un lado tiene 2 y otro 4 en un rectángulo, ¿si? Si esto es 4, esto también va a ser 4 [Dibuja un rectángulo y señala dos lados opuestos]. Si esto es 2, esto también va a ser dos [señala los otros dos lados opuestos]. ¿Cuál es el perímetro de esto?	OK. You can use your dot grid [points at John's dot paper.] Here in this one [pointing at the second row in the table in the textbook] you are telling me that a side is 2 and another one is 4, right? If this is four, this has to be 4 too [Draws a rectangle and points at opposite sides]. If this is 2, this is going to be 2 too [points at the other opposite sides]. What is the perimeter?
Lisa	Doce.	Twelve.
Señora Abad	¡Ajá! Entonces ese, está bien ese. Ahora tienes que buscar dos rectángulos mas que tengan un perímetro de doce.	Aha! So, this one, this one is correct. Now you have to look for two more rectangles that have a perimeter of twelve.

Several characteristics of the textbook work genre are present in this excerpt. Both teacher and students influenced the direction in which the conversation went. The teacher elicited students' thinking and definitions of concepts (i.e "¿Qué es perímetro?"—*what is perimeter?*). Students' questions had to do with the correctness of their answers, what they had to do, or specific definitions or procedures (i.e "¿Estamos sumando o multiplicando?"—*Are we adding or multiplying?*). Lisa presented her answers as questions, indicating the exploratory nature of her work and acknowledging that there was one correct answer that señora Abad could confirm. Modes of communication included spoken language, mathematical symbols and drawings.

Despite the interactive nature of the excerpt above, episodes in the textbook work genre did not necessarily involve student talk. Students could decide to work silently, as was the case at the beginning of the episode described here. Conversation frequently started when the teacher approached each pair. Although both the teacher and the students contributed to this conversation, students had the option of remaining silent or limiting their spoken utterances. For example, John only spoke once in the excerpt above and most of Lisa's turns consisted of one word. On the contrary, señora Abad's turns are longer and consist of full sentences. The focus of episodes in the textbook work genre was on mathematical ideas. These explorations, however, did not revolve around the generation of ideas but rather on recollection of definitions and

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strategies previously discussed. In the example above, the teacher did not elicit explanations or justifications. Instead, she gave definitions (i.e. "perímetro es afuera"—*perimeter is outside*) or reminders and students used phrases or isolated words to give answers.

In an interview, the teacher mentioned she used the textbook genre to review mathematical ideas, focusing on accurate application of procedures to get correct answers. The teacher used this genre after students had generated ideas and made sense of specific concepts. According to the teacher, she frequently drew on this genre as formative assessment that informed subsequent lessons, as well as a review before tests. In this example, the class had already discussed perimeter and area, and strategies to calculate each. The teacher mentioned that from previous lessons she had concluded the class needed to work on differentiating area and perimeter, which was one of her goals in this episode.

Language Episodes: Info Gap

In the info gap genre, students worked in pairs. Each student had some of the information necessary to solve a problem. The teacher gave a slip of paper to each student in a pair and students could not see each other's slip. One slip was designated "Student A" and the other one "Student B." First, each student needed to figure out what the information in the slip was by completing a language driven task. Then, students requested the missing information from each other. Although the information discussed was mathematical, the focus was on accurate production of the Spanish language.

One example of the info gap genre took place during the eighth lesson of the unit. In pairs, one student got a slip labelled Student A with information about a shape. This student needed to unscramble the words in each sentence. Student B had incomplete sentences about the same shape. This student needed to formulate questions to request the missing information. Señora Abad approached two students, Malik and Daniel.

Table 4. Example of the info gap genre.

Speaker	Original Utterance	Original Utterance
Señora Abad	¿Qué te hace falta aquí? [señalando la palabra "cuadrilatero."]	What's missing here? [pointing at the word "cuadrilatero."]
Malik	Oh! [Agrega tilde en "cuadrilátero."]	Oh! [Adds accent mark in "cuadrilátero."]
Señora Abad	Muy bien. [Murmura mientras señala cada frase.] Los lados cortos suman… La figura tiene… Hmm… ¿Cómo se dice esto?	Very good. [Whispering as she points at each sentence.] Both sides add up… The shape has… Hmm… How do you say this?
Malik	Oh! La figura tienes 4 ángulos rectos. Wait, no! Es correcto.	Oh! The shape have four right angles. Wait, no! It's correct.
Señora Abad	Hmm… ¿Recuerdas la historia de los caminos? Los caminos eran…	Hmm… Do you remember the story about the roads? The roads were…
Malik	Um largos y… Oh! [Borra "rectos ángulos" y escribe "ángulos rectos."]	Um long and … Oh! [Erases "rectos ángulos" and writes "ángulos rectos."]
Señora Abad	¡Muy bien! ¡Ángulos rectos! Ahora trabaja con Daniel que ya terminó.	Very good! Right angles! Now, work with Daniel; he is done.
Daniel	Ahora yo te pregunto.	I ask you now.
Malik	Mmhm.	Mmhm.
Daniel	¿Qué figura es?	What is the shape?
Malik	La figura es un cuadrilátero.	The shape is a quadrilateral.
Daniel	[Escribe en su papel] ¿Cuánto suman los lados adyacentes?	[Writes on his paper] What is the sum of the adjacent sides?
Malik	Los adyacentes lados suman nueve centímetros [Sonríe.]	The sum of the sides adjacent is nine centimetres[Smiles.] [Starts to write] What?! No!

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Daniel	[Comienza a escribir] ¿Qué?! ¡No! [Risas.]	[Laughs.] Malik, don't you know how to say this?
Daniel	Malik, ¿no sabes decir eso?	[Smiles] It's the sum of the adjacent sides is nine centimetres.
Malik	[Sonríe] Es los lados adyacentes suman nueve centímetros.	[Writes down.]
Daniel	[Escribe.]	

This example illustrates characteristics of the info gap genre. For example, students worked independently some of the time, with the teacher intervening only when she saw inaccuracies in language use. When the teacher intervened, she explicitly pointed at errors and asked the student to correct. That was the case when señora Abad asked Malik what was missing in the word he had spelled as "cuadrilatero" and when she asked him how to write a specific sentence ("ángulos rectos"). The questions señora Abad asked were not related to the mathematical meaning of the ideas in the slips. The teacher asked questions that drew Malik's attention to language inaccuracies ("¿qué te hace falta aquí?" and "cómo se dice esto"). Specifically, señora Abad asked "¿recuerdas la historia de los caminos?" referring to a short story the class had read about long roads and straight roads (caminos largos y caminos rectos) to focus on the noun-adjective word order in Spanish. Instead of inquiring about students' mathematical sense making of the ideas, the teacher focused on accurate spoken and written language production. That was the case when Malik playfully changed the standard "lados adyacentes" for "adyacentes lados" and how Daniel realised there was an error. Additionally, interactions in this genre were guided. Students engaged in the task writing or taking turns to ask and answer questions. Both students in the pair needed to communicate actively in order to complete the task.

In an interview, the teacher mentioned she used the info gap genre to focus students' production of mathematics discourse. Moreover, the class used the product of tasks in this genre as input for problem-solving tasks focused on mathematical ideas. Señora Abad commented that she drew on this genre when she thought it was necessary for the class to review the mathematical meaning and accurate use of specific terminology and phrases. The teacher mentioned that parents were frequently familiar with these tasks as associated with language learning and that they appreciated this focus on language. Therefore, she sometimes sent the individual part of these tasks as homework.

Discussion

This study suggests that the teacher navigated the competing demands by flexibly drawing on mathematics and language specific genres. The tasks, types of interactions, linguistic features, resources used, and purposes of episodes were similar within a genre and were typical to either mathematics or language teaching. This dynamic genre-switching resonates with Gerofsky's (1999) conceptualisation of genre-switching as a pedagogical tool to reach and support diverse students. Through genre-switching, the teacher foregrounded one of the two areas at different moments of the unit. In doing so, the teacher responded to mathematics and language related demands. This finding sheds light on how the teacher used genre-switching as a mechanism to respond to competing demands in a CLIL classroom specifically.

This study illustrates an analytical framework that does not disrupt the mathematics and language integration. By drawing on genre analysis of teaching episodes as associated with mathematics or language teaching, this study adds to previous research on CLIL mathematics classrooms that has mainly focused on students' language acquisition (Nikula et al., 2016). Rather than differentiating whether each teaching episode dealt with language or with

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mathematics, this genre analysis maintained the assumption that the two are inseparable. It was the types of tasks, interactions and teacher moves that were susceptible of being characterised as typical of a mathematics classroom or a language classroom. Analysis of teaching episodes focused on the interplay between mathematics and language during mathematical activity. During episodes in all genre categories the teacher provided opportunities to use and develop the language while simultaneously developing mathematical ideas.

This study attended to school influences on classroom interactions that the teacher perceived. Summative assessment, school pacing guidelines and parents' perceptions of language tasks informed how the teacher selected and sequenced specific genres. Characteristics of the school also informed the interplay between mathematics and language in this classroom. The teacher was a Latina, Spanish native speaker with formation in bilingual education. Moreover, she was aware of parents' interest in their children language proficiency. The school guidelines required the teacher to use Spanish at all times, resorting to English only to clarify specific words. Students had been in this language immersion classroom for nearly three years and were able to understand and maintain conversations in Spanish. Accordingly, in this classroom, Spanish was valued and positioned as useful at all times. In other contexts where language minority students learn mathematics in the community's dominant language, teachers frequently lower expectations, water down the mathematical curriculum or pull students out of mathematics classes until they develop what the school considers sufficient language proficiency (Setati & Moschkovich, 2013). In this classroom, rather than seeing students' language acquisition as a barrier, school, teacher and student characteristics supported the teacher's pursuit of mathematically challenging tasks in Spanish.

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