Teachers' use of language in multilingual mathematics classrooms during trouble-spots

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Abstract

Mathematics teaching in a foreign language may lead to discrimination for some learners specifically during trouble-spots that require the construction of shared-understanding. This research compares teacher-learner interaction in two classrooms of Lebanon where mathematics is taught in a foreign language. Eighteen lessons were recorded and transcribed, and utterances of teacher and learners were coded at the levels of: school; session; interlocutor; language use; move and function. Quantitative analysis of language use and qualitative illustrations of representative sequences are reported. The triadic dialogue as the dominant mode of interaction and the multilingual nature of language were found unique aspects of classroom teacher talk. Differences in the roles of language as a resource for meaning-making were also identified. Findings are discussed within sociocultural and ethnomethodological views of language as a medium to achieve mathematics teaching and learning.

Keywords. Teacher-learner interaction; classroom teacher talk; trouble-spot; language; multilingual classrooms.

La lengua en uso de profesores en aulas de matemáticas multilingües durante focos de tensión

Resumen

La enseñanza de matemáticas en una lengua extranjera puede conducir a la discriminación de algunos alumnos particularmente durante focos de tensión que requieren de la construcción de comprensión compartida. Esta investigación compara la interacción profesor-alumno en dos aulas del Líbano donde las matemáticas se enseñan en una lengua extranjera. Se grabaron y transcribieron diechiocho sesiones de clase, y las intervenciones de profesor y alumnos se codificaron a nivel de: escuela; sesión; interlocutor; uso de la lengua; movimiento y función. Aquí se documentan el análisis cuantitativo del uso de la lengua e ilustraciones de secuencias representativas. El diálogo triádico como modo dominante de interacción y la naturaleza multilingüe de la lenga aparecieron como aspectos únicos del habla del profesor en clase. También se detectaron diferencias en el papel de la lengua como recurso para producir significado. Los resultados se discuten con visiones socioculturales y etnometodológicas de la lengua como medio para lograr enseñar y aprender matemáticas.

Palabras clave. Interacción alumno-profesor; habla del profesor en clase; foco de tensión. lengua; aula multilingüe.

1. Introduction

Classroom teacher talk and the ways in which different languages (e.g. colloquial, foreign) are used within multilingual classroom environments are fundamental for supporting meaningful mathematics teaching and learning (Adler 1999; Khisty & Chval, 2002). From this perspective, research in mathematics education needs to study classroom teacher talk and language practices in multilingual classrooms and their impact on teaching and learning; particularly, for learners from low or middle socioeconomic status. These learners frequently face a linguistic discrimination by which lack of proficiency in the foreign language, used as the language of instruction, may be a factor contributing to poor accomplishment in learning mathematics.

The current research addresses multilingual classrooms in Lebanon, a Middle Eastern country, in which private precollege education serves almost 60% of K-12 students whereas public school system provides almost tuition free education to 40% of students. In Lebanon, mathematics and science are taught in a foreign language based on a policy that was established in 1926 during the French Mandate. While very few schools use Arabic as language of instruction to teach mathematics and science at the elementary school cycle (grades 1-6), a foreign language (English or French) is used as a language of instruction for teaching mathematics and science in the public and private sectors. Teachers and students in Lebanon are multilinguals with Lebanese colloquial Arabic as their native spoken language, Arabic standard language as their language of literacy and English or French, as the language of instruction for mathematics and science. The feature of multilingualism in mathematics and science classrooms in Lebanon is not only given by using a foreign language but also given by two varieties of Arabic language, standard Arabic and colloquial Arabic. All these languages 'come together' for mathematics and science education in a unique way.

I explore the effects of using Lebanese spoken colloquial Arabic as a resource for meaning-making during 'trouble-spots' (Alibali et al., 2013) when learners commit errors, hesitate or have no shared understanding with the teacher. In particular, I explore regularities in classroom talk when learners begin to encounter algebra in grade seven. I examine whether various regularities in the use of home language, in this case colloquial Arabic, and language of instruction impact on the pedagogical quality of classroom teacher talk during trouble-spots. To this end, I compare and contrast classroom teacher talk in two grade seven classrooms in a public and a private school. I draw on sociocultural and ethnomethodological approaches in mathematics education. Adopting both theoretical approaches allows me to conceptualize language as a medium to achieve mathematics teaching and learning in classroom interaction and to consider the role of language as a resource for meaning-making.

2. Theoretical approaches to analyze language use in classroom interaction

In recent investigations, a combination of theories from various disciplines has framed research in mathematics education to explore relationships between language, classroom interaction and learning. The current study uses sociocultural and ethnomethological approaches to analyze language use in multilingual classroom interaction. Classrooms, as social contexts, are usually framed within a sociocultural theory of learning with a focus on the role of language in mathematics teaching and learning. The principles of this theory originate in Vygotsky's (1978, 1986) sociocultural theory, which focuses on symbolic tools (e.g. language) as media of communication and reasoning. Ethnomethodology has also been used in mathematics education. The foundations of this theory were developed by Garfinkel (1967). Based on this theory, research in mathematics education focuses on how language is used as a medium to achieve mathematics teaching and learning in classroom interaction instead of focusing on the language per se. Ingram (2018) argues that ethnomethodology allows thoroughness to analyze classroom interaction since it "is both a theoretical perspective on social actions and a method for researching these actions" (p. 1065). Here, interaction becomes the unit of analysis by focusing on what the teacher and/or students "are doing with their utterances or gestures in this interaction" (p. 1065). The focus becomes on what those interlocutors utter and how they state their utterances, and hence it allows for the examination of classroom interaction complexity and the focusing on characterizing structures and regularities of interaction.

Paying attention to the specifics of classroom teacher talk reveals variations within broader discourse regularities thus permitting for further consideration of quality of education. Within this perspective, research in education relates interaction to the type of discourse in classroom teacher talk, and consequently its impact on quality of teaching and learning. For instance, research distinguishes between univocal and dialogic discourse in classroom teacher talk. Univocal discourse occurs when classroom interaction focuses only on producing a form of communication in which the student receives the "exact" message that the teacher expects to be received. In contrast, dialogic discourse is manifested when classroom interaction involves dialogue as a process for reasoning (Wertsch, 1991). The concept of dialogicity is based on Bakhtin's (1981) theory of language, which perceives language as dialogic. El Mouhayar (2020a) and Salloum and BouJaoude (2019) suggest that univocal discourse hinders conceptual understanding, whereas dialogic discourse supports it.

Another example of regularities in classroom interaction is the triadic dialogue. This turn taking structure follows initiation-response-follow-up moves. It was first outlined by Sinclair and Coulthard (1975) and then various studies in mathematics and science education explored this pattern in different countries (e.g. Amin & Badreddine, 2020; El Mouhayar, 2019, 2020a, 2020b, 2021; Lemke, 1990). Acknowledging the versatile nature of triadic dialogue, El Mouhayar (2020a) shows how this mode has been utilized by a teacher in a Lebanese multilingual mathematics classroom, where English is the language of instruction, to manage shifts between pre-algebraic and algebraic generalization levels of reasoning and among knowledge types. Dialogic teaching was found dominant, although there were some indicators of univocal classroom teacher talk. The dialogic discourse allowed the teacher to play roles as initiator and secondary knower, thus influencing the quality of teaching and learning.

The present study focuses on documenting classroom interaction between the teacher and learners when algebra is taught in a foreign language. I study how interaction regularities in a triadic dialogue mode of interaction and multilingual setting vary as a function of various modes of language use in multilingual classrooms.

3. Language as resource for meaning-making during trouble spots

Attention to meaning of language is essential for classroom interaction (Moschkovich, 2008; Khisty & Chval, 2002). In many countries, the language of instruction in mathematics classrooms is different from the local spoken language due to economic and political reasons. In these countries, students bring with them their home languages. As a result, mathematics teachers are obliged to deal with language diversity during classroom talk. Recent work in sociolinguistics of multilingualism and in mathematics education on multilingual classrooms has stressed the value of perceiving students' linguistic repertoires as resources. Current research discusses the diversity of language use as (re)sources for meaning-making (e.g. Barwell, 2018; Moschkovich, 2008; Planas, 2018, 2021; Planas & Setati-Phakeng, 2014).

Regarding the conceptualization of language as a resource for meaning-making, Moschkovich's (2008) examines students' ability to draw on resources from everyday experiences as well as resources from the classroom such as gestures and drawings. Planas and Setati-Phakeng (2014) refer to language simultaneously as a problem, as a right and as a resource, with emphasis on the latter perspective. Here, home language can be seen as a right in multilingual mathematics teaching and learning, while learning mathematics in a foreign language can be seen as a problem. Tensions can thus appear

along teachers' attempts to manage both teaching mathematics and teaching the language of instruction (Planas & Setati-Phakeng, 2014). Mathematics education researchers with a focus on multilingual issues hold a similar view, namely, that language as a resource for the development of meaning-making goes with tensions between languages (Planas, 2018). Exploring tensions in multilingual mathematics classrooms was initiated by Adler's key work on dilemmas (2001). Adler refers to three dilemmas (code-switching, transparency and mediation) as a resource for making meaning in multilingual classrooms. She argues that these dilemmas "lie at the heart of teaching and learning secondary level mathematics in multilingual classrooms" (p. 1).

Studies on multilingual mathematics classrooms in various parts of the world like South Africa (Adler, 2021), Catalonia, Spain (Planas, 2018), Malta (Farrugia, 2009), or California, United States (Moschkovich, 2008) illustrate the value of language as resource for meaning-making. They show teachers and learners using their spoken language and the language of instruction to engage meaningfully in classroom interaction. Code-switching, or multilinguals moving between languages during a conversation or at the level of an utterance (Farrugia, 2009), is valued as a strategic resource for meaning-making and to deal with challenges resulting from using various languages. Adler (2001) and El Mouhayar (2021) report teachers resorting to code-switching as a skillful and deliberate mode of instruction. It is shown teacher's code-switching to provide feedback in order to make content accessible to students, to refer to mathematical technical terms; or to connect language and other representations.

4. Design of the research and methods

This research studies classroom talk when early algebra is taught in a foreign language in the middle school. My guiding question is: How does language use in teacher talk vary during trouble-spots in early algebra-specific multilingual classrooms? Even though I take Vygotsky's sociocultural approach as key, I acknowledge the dialogic nature of interaction, and refer to language as resource for learner meaning-making. I place the spot light on the teacher's utterances because of their fundamental role in classroom interaction. With this focus, I align with research in mathematics education on teacher talk, teaching and language in classrooms (Adler, 2021; Planas, 2021). Overall, the focus herein is on the role of teacher talk in the multilingual mathematics classroom, particularly in the interaction between teacher and learners during trouble-spots. I explore regularities in classroom teacher talk of two grade seven classrooms and compare those regularities in terms of language use.

The study was conducted in Lebanon, where most private and public schools follow the national mathematics curriculum that is content-oriented with algebra as a major topic. The data for the study comes from two grade seven mathematics classrooms –one in a public school (Nour's class), in which French is the language of instruction and the other (Elie's class) in a moderately sized private school, in which English is the language of instruction. Both schools are located in a suburb in the greater Beirut area serving middle to low socio-economic background students as reflected in the schools' achievement levels. Eighteen sessions in grade seven in the two schools were video-and-audio taped, ten of which occurred in the private school. Videotapes were transcribed verbatim and transcriptions were coded based on Wells (1999) to monitor sequential features of classroom discourse interaction. According with Amin and Badreddine (2020) where exchange is the central feature, the least possible unit of spoken discourse interaction between speakers was preserved, which involved initiation and response moves. An exchange may also entail a follow-up move, in which the speaker may

reformulate, repeat or justify a response. Sequences constitute levels broader than an exchange. A sequence enables perceiving interaction as a chain of exchanges of two types, nuclear and dependent. In a nuclear exchange, a novel topic is inserted. This type has a specific extent of independence from preceding exchanges and can be self-contained. A dependent exchange is a type that does not stand by itself since it depends on the presence of a preceding nuclear exchange.

Coding was done at the levels of exchange type (nuclear, dependent) and of sequence. I aimed at getting a picture regarding the development of interaction in a classroom and identifying trouble-spots. The analysis was done qualitatively and quantitatively to capture various ways in which interaction evolved during trouble-spot-sequences (TSS) and the modes of language use during those TSS. Initiation, response and follow-up are distinguishable moves within an exchange. Each of those moves correspond to one utterance and every utterance was also coded with respect to the function it serves (Amin & Badreddine, 2020; Wells, 1999). So, every utterance was coded for the classroom in which it occurred (Elie or Nour's) and the interlocutor (teacher or student). Moreover, each utterance was coded based on the language used. As a result, three modes of language use within an utterance emerged: (1) English-only or French-only; (2) Arabic-only; and (3) mixed languages whenever there is a mix of Arabic and English or French. To establish reliability in coding, a team of four research assistants coded the data under my guidance. The interrater reliability between coders during a final stage of coding was more than 80%. This score was used to establish reliability in coding exchange type, sequence, trouble-spot, move, function and utterance type. 8966 utterances out of 11122 utterances were finally considered. Those utterances contributed to classroom interaction during TSS.

5. Selection of findings

I now focus on identifying commonalities and discrepancies that exist during TSS between the two classrooms, in terms of language use, moves and functions. While quantitative analysis shows regularities within each classroom as well as similarities and contrast differences in language use, qualitative analysis serves to select representative excerpts around the guiding question stated for the study.

5.1. Comparing the language of instruction and home language

Interaction in the two classrooms mainly followed the triadic dialogue structure with teacher initiation, student response and teacher follow-up moves. This section starts with a description of the language of instruction and colloquial Arabic by the teachers during TSS as they taught algebra. I then report dominant discourse regularities and compare commonalities and discrepancies.

Table 1 shows the percentage use of the language of instruction (English or French) or the home language (colloquial Arabic) during TSS, either separately or mixed within an utterance. Elie's home-language mixed with English is reflected in his greater utilization of code-mixing (56.1%) compared to his utilization of English only (31.7%). Nour's French only is reflected in her greater utilization of language of instruction (61.8%). Moreover, learners in Elie's class utilized mixed-languages with a larger percent -37.6% of the utterances- than learners in Nour's class who only utilized code-mixing in 14.7% of utterances. In contrast, the degree of learners' participation in the two classrooms is similar. Learners in Elie's class contribute 35.3% of the utterances compared to 38.4% in the case of Nour's class.

Table 1. *Cross-tabulation of language use by interlocutor and by classroom during TSS*

		Diversity in language use									
		Foreign instructional language		Colloquial Arabic		Mixed languages		Other*		Total	
Classroom		Freq.	%	Freq.	%	Freq.	%	Freq.	%	Freq.	%
Elie	Teacher	548	30.7	158	8.9	1073	60.1	5	0.3	1784	100
	Learner	458	46.5	117	11.9	373	37.9	37	3.8	985	100
	Total	1006	36.3	275	9.9	1446	52.2	42	1.5	2769	100
Nour	Teacher	2428	62.1	545	13.9	936	23.9	0	0	3909	100
	Learner	1696	74.1	230	10.1	361	15.8	1	0	2288	100
	Total	4124	66.5	775	12.5	1297	20.9	1	0	6197	100
Total	Teacher	2976	52.3	703	12.3	2009	35.3	5	0	5693	100
	Learner	2154	65.8	347	10.6	734	22.4	38	1.2	3273	100
	Total	5130	57.2	1050	11.7	2743	30.6	43	0.5	8966	100

* Other category corresponds to gestures such as nodding or writing

5.2. Illustrations of distinguished interaction routines and language use

While findings show a larger extent of home language during TSS in Elie's class, Nour and learners utilize French to a larger extent. The excerpts below, showing dominant discourse patterns and trends of interaction from each class, illustrate those discrepancies during TSS. The first excerpt shows continual use of mixed languages, including home language and English in Elie's class during TSS. This excerpt involves classroom teacher talk of the "flock of birds" pattern (Figure 1), in which Elie uses the figure of the arranged flock of birds on day one to discuss with learners a formula to determine a relation between number of days and total number of birds.

During winter, birds migrate towards countries where the weather is warmer. These birds fly in the form of a V-shape. On the first day only three birds were flying. Every day, two birds join the flock while maintaining the V -shape. The figure below shows the number of birds flying on the first day.

Figure 1. Flock of birds

The representative sequence illustrates characteristics that are common in the discourse pattern in Elie's class. It first shows strict triadic dialogue in which the initiation and follow-up moves are performed by Elie whereas the responses are contributed by leaners. It then shows continuous use of mixed-languages (colloquial Arabic and English) by Elie and learners. Bold words denote Lebanese Arabic whereas bold and italicized words denote translation of Arabic to English.

1	Teacher:	Question number two: let D be the number of days…day number. And let B be the total number of birds.	Initiate	Read	Nuclear Exchange

		طلعوا بشي ***come up with a*** formula between B number the birds and D the day number. Maggie **ب طلعت *came up with a*** formula for birds joining the flock. **لل *for the*** formula **نحن بدنا** ***we want*** the total number of birds **هول كيف عم يتغيروا**? ***Those, how are they changing?*** What's the pattern between these figures? Rayan and Ali		Request action Acknowledge Clarify Request suggest Nominate	
2	Rayan:	We take the number of birds joining the flock and the total number of birds….	Respond	Suggest	
3	Teacher :	**بدنا** ***we want*** formula for the total number of birds **شو ال**formula **يللي طلعتوا فيها؟** ***What is the formula that you came up with***?	Follow-up Initiate	Clarify Request suggest	Dependent Exchange
4	Rayan:	**منعمل *we do*** five minus two equal three	Respond	Suggest	
5	Teacher :	Five minus two equal three	Follow-up	Repetition	
6	Rayan:	Five minus two gives three which is the constant number of the birds.	Respond	Clarify	
7	Teacher :	**ال أول شي *first thing the*** formula **بعدين بتشرحيلي اياها *then you explain to me***. What's your formula? The formula **متل هاي لازم يكون فيها *should contain such as those*** B and D.	Follow-up	Request suggest Clarify	
8	Rayan:	Birds joining the flock minus the total number of the birds.	Respond	Suggest	
9	Teacher :	**ارجعي عيدي *repeat again***	Follow-up	Request repeat	
10	Rayan:	Birds joining the flock minus the total number of the birds.	Respond	Repetition	
11	Teacher :	Total number of birds **يعني *means*** B **شلتي منها *you took from it*** the birds joining the flock **وبعدين شو عملتي بالجواب *and then what did you do with the response***?	Follow-up	Clarify Request suggest	
12	Rayan:	**بعدين منجمعه مع** ***then we add it with*** birds joining the flock. **بيطلع الجواب**	Respond	Suggest Inform	

		the result will be obtained for the total number of birds			
13	Teacher:	**بيطلع الجواب *the result will be obtained*** for the total number of birds? Okay.	Follow-up	Request confirm Acknowledge	
14	Teacher:	فيكم تقولولي، قبل ما نجربها، شو يللي ما عجبكم بهاي الformula يللي عطاها هالgroup. قبل ما نجرب، شو في شي as a first glimpse لفتلك نظرك؟ في شي ما استعملوه؟ ***Can you tell me, before we try it, what you did not like in thi***s formula ***that this*** group ***has suggested***. ***Before we try, what is there*** as a first glimpse ***that captured your attention***? Fadel	Initiate	Request evaluate Request inform Evaluate reject Nominate	Dependent Exchange
15	Fadel:	D	Respond	Inform	
16	Teacher:	The day number. Their formula is independent of, **مستقلة عن *independent of,*** the day number. **بالنسبة الهم *for them*** the day number is not essential. **خلينا نجرب *let us try***. **بالرغم من انه ما في *even though there is no*** day number. **بنقي *should I select*** أي ***which*** number? ***did you notice the problem that we are facing*** **لاحظتوا المشكلة يللي عم نوقع فيها**? ***here I select*** **هون بنقي** day number ***and I try it*** **وبجربها**، ***but here there is no*** **بس هون ما في** day number، ***in order to try*** **حتى جربها** ***I have to*** أي ***which*** day number **بدي جربه** try?	Follow-up	Inform Evaluate reject Clarify	
17	Rayan:	Any day.	Respond	Justify	
18	Teacher:	Any day? Day five **لازم يطلع *should be*** eleven birds Okay. The total number of birds B equal to B. ***in order to get*** **لجيب** the total number of birds ***I should know*** **لازم اعرف** the total number of birds?! **شفتوا وين المشكلة يللي عم نوقع فيها*did you see the problem that we are facing***? Total number of birds is total number of birds.	Follow-up	Request confirm Clarify Inform	
19	Teacher:	**فهمتوا وين المشكلة**	Initiate	Check Request inform	Dependent Exchange

		Did you understand where the problem is? Please, help us **وين عم بتلاقي مشكلة** ***Where are you facing a problem*** in applying this formula? **وين في** ***where is there*** another problem **غير *other than this*** B equal to B **هاي** Jerald		Request inform Nominate
20	Jerald:	**كيف فينا نعرف ال** ***how can we know the*** total number of birds **اذا ما منعرف شو هني** ***if we do not know what they are?***	Respond	Inform
21	Teacher:	Okay. What about the birds joining the flock? **كيف بدي اعرف قدي *how can I know how much is*** the number of birds joining the flock? On day twenty-five for example, **كيف بدي اعرف *how can I know*** how many birds joined the flock on day twenty-five? There are so many problems with your formula, but at least you tried. That's okay.	Follow-up	Acknowledge Inform Evaluate reject
22	Teacher:	Write it and explain by words **ليش طلعتوا بهاي الفكرة وليش ما اخدتوا بعين الاعتبار *why did you come up with this idea and why you did not take into consideration day number***? There should be a reason for that. Okay?	Initiate	Request justify

Figure 2. Excerpt from Elie's class TSS with mixed-language and triadic dialogue

The excerpt contains four turns of the teacher utilizing the "request inform" or "request suggest" functions in the initiate move (turns 1, 14, 16 and 18). Contrary to asking for information, there is more than one possible correct response to the "request suggest". When the teacher requests a suggestion, more than one response would be adequate. He requests a suggestion from a number of possible ways in finding a relation between day number and the number of birds (e.g. turn 3) or in seeing variants (e.g. turn 1). Another feature more typical of Elie's class is the nominate function. Three turns of the teacher show the nominate function in the initiate move (turns 1, 13 and 18). This use of nominate illustrates how Elie controls the interaction and the contribution of the learners by selecting who is going to respond to his questions.

This TSS also illustrates features more typical in Elie's follow-up moves. It reveals five instances of the *clarify* function in the follow-up move (turns 3, 7, 11, 16 and 18). Clarification in the follow-up move depicts Elie's focus on mixed languages as a resource for meaning-making. In turn 16, Elie rephrases Fadel's brief response (D in turn 15) using mixed languages with English for technical language "day number" and colloquial Arabic for deictic function "هون (here)" and reference to students "بالنسبة الهم

(for them)". The excerpt contains two turns of request confirmation function (turns 13 and 18) and one turn for requesting information in the follow-up moves (turn 18).

More typical of Elie's class are also teacher's conceptual and procedural-inquiry utterances. While conceptual utterances involve learners in making connections that enable them to function together within the larger structure, procedural inquiry utterances address how to do something such as processes of inquiry (e.g. observe, compare) (El Mouhayar, 2020a). Elie involves learners in determining a formula that associates the number of birds with the day number. He infuses conceptual utterances about this relation in turns 1, 14, 16 and 19. The dominance of conceptual talk could be designated to the nature of discourse, which involves determining a relation between day number, total number of birds and number of birds joining each day.

A fourth feature of Elie's class is that utterances of learners' responses are brief, limited to a few words or short statements. Elie and learners use mixed languages in almost all utterances in the TSS for various functions. They use colloquial Arabic to refer to: (1) demonstratives such as "هول [those]" (turn 1), and deictics such as "أول شي [first thing]" (turn 7) to address specific issues in dealing with the formula; (2) interconnectivity means including copular verbs such as ""طلعوا بشي [came up with] (turns 1, 7 and 8); (3) conjunctions such as "لل [for]" (turn 1), "ال [the]" (turn 7), and "بعدين [then]" (turn 7). They also use colloquial Arabic to refer to personal voices. This is illustrated by teacher's utterances (turn 3) such as "بدنا [we want]" and students' utterances such as "منعمل" [we do] (turn 4). Elie uses English to refer to technical words like "total number of birds" or "number of days" or "formula" (turn 7).

The excerpt from Nour's class differs from Elie's in terms of functions related to interaction moves, language, utterance knowledge type and mathematical lesson. The excerpt corresponds to a lesson dealing with algebraic expressions with a focus on reducing, simplifying, developing, and factorizing algebraic expressions. Teacher and learners are discussing what to do with the expression 5x+3. This excerpt shows dominant use of French and strict triadic dialogue where teacher's moves mainly contribute to *initiation* and *follow-up* moves. Bold words denote Lebanese Arabic whereas bold and italicized words denote translation of Arabic to English. Non-bold but italicized words denote translation of French to English.

1	Teacher:	Si j'ai cinq x plus trois **و قلنالكن** de choisir la réponse *If I have five x plus three **and we told you** to determine the response*	Request inform	Initiate	Nuclear Exchange
2	Students:	Huit x *Eight x*	Inform	Response	
3	Teacher:	alors que **ادّي حكيت انا انّو هيدا**? C'est un monôme constant. **هون**, il n'y a pas x alors que là vous avez le terme x**هيدا** *but **how many times did I say that this** is a constant monomial. **Here**, there is no x whereas here you have the term x. **This one***	Inform	Follow-up	
4	Teacher:	Est-ce que ceux sont deux monômes semblables? *Are those two similar monomials*?	Request pos/neg	Initiate	Dependent Exchange

5	Students:	Non *No*	Pos/neg	Response	
6	Teacher:	Non, ils n'ont pas la même partie littérale, ici, je ne peux pas les additionner *No, they do not have the same literal part, here, I cannot add them.*	Reformulate Extend	Follow-up	
7	Joe:	Madame *Miss*	Bid	Initiate	Dependent Exchange
8	Teacher:	**إيه** ***Yeah***	Nominates	Response	
9	Joe:	Cinq x plus trois. **منعمل** trois x plus cinq *Five x plus three* ***we do*** *three x plus five*	Suggest	Initiate	
10	Teacher:	Ahh. **انتبهو شوي**. Trois x plus cinq **و** cinq x plus trois **هاو متل بعضن؟** *Ahh.* ***Pay attention****. Three x plus five* ***and*** *five x plus three.* ***Are those similar***?	Request action Reformulate Request pos/neg	Initiate	
11	Students:	Non *No*	Pos/neg	Response	
12	Teacher:	Trois x **متل** cinq x **يا** Joe? *Is three x* ***similar*** *to five x* ***oh*** *Joe*	Request pos/neg	Initiate	Dependent Exchange
13	Joe:	Non *No*	Pos/neg	Response	
14	Teacher:	**ل** cinq **متل ل** trois ? *Is* ***the*** *five* ***similar*** *to* ***the*** *three*?	Request pos/neg	Initiate	Dependent Exchange
15	Students:	**لأ** ***No***	Pos/neg	Response	
16	Teacher:	Trois x plus cinq **متل** cinq plus trois x, **بسّ مش متل** cinq x plus trois.**لأنّو نتبه. هون** nous avons trois x. Quel est le terme qui contient x ici? *Three x plus five* ***is similar to*** *five plus three x,* ***but not similar to*** *five x plus three.* ***Because pay attention. Here*** *we have three x. What is the term that contains x here?*	Inform Request inform	Initiate	Dependent Exchange
17	Students:	Trois *Three*	Inform	Response	
18	Teacher:	Trois *Three*	Repetition	Follow-up	
19	Teacher:	Que veut dire 3x? *What does three x mean*?	Request inform	Initiate	Dependent
20	Etian:	*X fois x fois x* *X times x times x*	Inform	Response	Exchange

21	Teacher:	Trois x n'est pas x fois x fois x لأ. ***No**. three x is not x times x times x*	Evaluate reject	Follow-up	
		Trois x c'est x plus x plus x. C'est la somme de x *Three x is x plus x plus x. It is the sum of x*	Reformulate		
22	Etian:	Plus? *Plus?*	Request confirm	Initiate	Dependent
23	Teacher:	إيه. C'est x plus ***Yes**. It is x plus*	Pos/neg Reformulate	Response	Exchange
24	Teacher:	Quel est le coefficient? *What is the coefficient?*	Request inform	Initiate	Dependent
		Ceux ne sont pas ici des monômes semblables يا Etian? *Are those similar monomials **oh** Etian*	Request Pos/neg Nominate		Exchange
		Quel est le coefficient ici? *What is the coefficient in here*?	Request inform		
25	Students:	Un *One*	Inform	Response	
26	Teacher:	Un et un et un *One and one and one*	Inform	Follow-up	
27	Teacher:	Comment ? qu'est-ce que j'additionne? *How? What do I add?*	Request inform	Initiate	Dependent Exchange
		Les coefficients c'est-à-dire c'est égal à un plus un plus un facteur de x. Alors que x fois x fois x, vous avez ici comme exposant الذي? C'est x à la puissance? *The coefficients, this means it is equal to one plus one plus one as a factor of x. Whereas x times x times x, you have in here the exponent, **what is its value**? It is x to the power?*	Inform Request inform		
28	Student:	Trois *Three*	Inform	Response	
29	Teacher:	Trois *Three*	Repetition	Follow-up	
		Donc x à la puissance trois est le produit de x trois fois par lui-même alors que trois x c'est la somme de x trois fois, n'est-ce-pas? *So x to the power three is the product of x three times by itself whereas three x is the sum of x three times, right?*	Reformulate Request pos/neg		
30	Students:	Oui *Yes*	Pos/neg	Response	
31	Teacher:	D'accord? *Okay?*	Check	Initiate	

32	Students:	Oui *Yes*	Pos/neg	Response	Dependent Exchange
33	Teacher:	Bon *Good*	Evaluate accept	Follow-up	

Figure 3. Excerpt from Nour's class TSS with dominant French and triadic dialogue

First, the excerpt reveals several initiate move utterances in which Nour requests factual information (turns 1, 16, 19, 24 and 27). Contrary to the request suggest function, the request information involves asking a question regarding a specific topic for which only one specific response is possible. This response can either be correct or incorrect. In turn 16, the teacher asks, "Here we have three x. What is the term that contains x here?" The correct response was said by a student "three" (turn 17). The TSS also contains an *initiate* move where Nour provides factual information (turns 16 and 27) with basic elements that learners must know to manipulate algebraic expressions or to solve the problem. "Three x plus five is similar to five plus three x, but not similar to five x plus three" (turn 16) shows factual information that learners must know to deal with algebraic expressions. Asking for a yes or no response appears several times in the initiate moves of the teacher (turns 4, 12, and 14) even though this function is not among the first six dominant functions in Nour's moves.

The excerpt also illustrates features more typical in Nour's follow-up moves. It contains two instances of offering information (turns 3 and 26), and two of repeating a learner's response (turns 18 and 29). Another feature more typical of Nour's class are teacher's extensive factual and procedural-algorithmic utterances. While Nour's factual utterances involve basic elements that learners must know to manipulate the algebraic expression, procedural-algorithmic utterances address how to use and apply formulas and procedures related to algebraic expressions. In this TSS Nour involves the learners to compare how to carry out the multiplication of x three times and sum of three x, "So x to the power three is the product of x three times by itself whereas three x is the sum of x three times" (turn 30). As a result, Nour infuses factual utterances (e.g. turns 1, 16, 19, 24 and 27) and procedural-algorithmic utterances (e.g. turn 30). Similarly, learners' utterances are at the factual level (e.g. turns 3, 13, and 17, 25 and 28). The dominance of procedural and factual talk could be designated to the nature of the discourse, which involves carrying out various operations on algebraic expressions.

The mixing of language of instruction and colloquial Arabic in Nour's class is very different to that in Elie's. This TSS illustrates this distinction regarding the functions associated to interaction moves and characteristics of language use. What is noteworthy is that Nour rarely uses colloquial Arabic and learners stick to using the language of instruction. Additionally, reference to Arabic is limited to one to two words within an utterance. It is very rare that the teacher refers to more than two Arabic words within an utterance (e.g. turns 3, 10 and 16). The majority of colloquial Arabic words play a role in managing the flow and structure of the discourse. However, those terms do not make a change to the mathematical meaning related to the discourse in the sequence. The teacher uses colloquial Arabic for the purposes of connectivity including copular verbs such as "منعمل [we do]" (turns 6, 7 and 8) or conjunctions such as "لأنّو [because]" or "بسّ [but]" in (turn 16) "و [and]" (turns 1 and 10), "then" (turn 8) and "ل [the]" (turn 14). In turn 16 Nour uses "but" to introduce a new statement "but not similar to five x plus three" that adds to, "three x plus five is similar to five plus three x" and contrasts with it in some way. Some colloquial Arabic words play the role of discourse markers such as "إيه [yeah]" (turn 8) and "يا [oh]" (turns 12 and 24) to nominate a student. Nour also uses colloquial Arabic words to refer to deictic functions such as "هون [here], "هيدا [this]"

(turn 3) "هاو [those]" (turn 10) to refer to parts of the algebraic expression on the board. So, deictics are used to focus attention on specific objects of the algebraic expression on the board accompanied by hand pointing. Colloquial Arabic is used to refer to pronouns "انا [I]" (turn 3) or for evaluation such as "إيه [yes]" (turn 23) or "لأ [no]" (turn 15).

To sum up, Elie's greater utilization of colloquial Arabic is associated with a greater focus to involve learners in higher level reasoning (conceptual and procedural-inquiry knowledge types). In contrast to Nour, Elie consistently and frequently utilizes home language, which play various roles in the process of generalization. Elie is more likely to use colloquial Arabic to refer to (1) deictic means; (2) adverbs of generative action; (3) pronouns; (4) calling out numbers and operations; (5) copular verbs in addition to other usage such as affirmation, negation, and request for justification or to request other strategies or for management. Those linguistic terms are associated with the content of the mathematical topic or discourse. Nour, on the other hand, involves learners in lower level reasoning (factual and procedural-algorithmic knowledge types) in alignment with the tasks in the textbook. Nour's colloquial Arabic can be considered as limited to managing the flow of the discourse. Nevertheless, the TSS in this study were selected to illustrate contrast and to emphasize discrepancies that were highlighted in the quantitative analysis. There are large differences that exist within each of the two classrooms. In the next section I discuss findings with an emphasis on their implications in relation to the question of how colloquial Arabic influence classroom teacher talk during the teaching of algebra in the middle school.

6. Discussion

This study has investigated the association of language use and patterns of interaction between teacher and learners during trouble-spots in two grade seven multilingual classrooms. I now further discuss the findings in the light of the theories undertaken. By adopting ethnomethodology, I focused my analysis on the interactions between learners and teacher and on what they utter and how to state their utterances. This allowed me to examine classroom interaction complexity and to focus on characterizing structures and regularities of interaction in teaching algebra and during multilingual trouble-spots. Overall, triadic dialogue was found in both classrooms, with function that were content oriented. Nevertheless, conceptual and procedural-inquiry knowledge types characterized the discourse elicited in Elie's class, whereas factual and procedural-algorithmic knowledge were dominant features of discourse in Nour's class. In his follow-up moves, Elie intended to scaffold learners' reasoning with mixed languages (colloquial Arabic and English). Nour showed more interest in content with low-level reasoning. Her follow-up moves were more likely to repeat a learner's response or to request factual information. This was associated with limited colloquial Arabic for discourse markers. It can thus be concluded that the quality of discourse in Nour's class resembles Wertsch's (1991) univocal discourse. In contrast, the quality of discourse in Elie's class resembles Wertsch's dialogic discourse.

While the study is limited to two classrooms and the lessons are content-specific, systematic and comparative analyses of interaction, and the choice to adopt the view of languages as being distinct with a focus on teacher talk, show home language as a resource for mathematical meaning-making. Language in classroom teacher talk was coded at broad levels to classify categories that are not content specific even though the illustrations analyzed are content specific. As such, this study adds to mathematics education literature on exploring content-specific language in classroom teacher talk with the aim to begin to see the general (e.g. Adler, 2021; Planas, 2021).

The practices in both classrooms indicate that the two teachers view language as a resource. The analyses reveal code-mixing and colloquial Arabic as natural move between languages during teacher talk. Moves between colloquial Arabic and English or French during classroom interaction created a notable aspect of discourse that helped to involve learners in learning. While it can be concluded that participants in both classrooms perceive language as a resource, it is unclear whether the value of this resource is similar. Quantitative analysis shows that Elie refers to colloquial Arabic more frequently than learners. This may be due to the higher frequency of teacher's utterances during TSS. Reference to colloquial Arabic was accompanied with code-mixing, with one or more words borrowed from English and embedded into teacher's or learner's utterance. Elie code-mixes and while doing so, he refers to technical terms in English such as "figure" or "squares". This may be due to rare use of those terms in colloquial Arabic in every day experience. By using those terms in English, the teacher aims that learners understand and employ those mathematical technical terms in English. As for Nour and learners, the use of colloquial Arabic is limited.

Mixed language use in each classroom and how colloquial Arabic and language of instruction were used in teacher talk can be discussed from the conceptualization of language as resource for meaning-making (Planas, 2018, 2021; Barwell, 2018), and from the perspective of seeing language as right or as problem (see Planas & Setati-Phakeng, 2014). The teacher in the mixed-language dominant classroom made explicit comments about language that can be viewed from language-as-right and language-as-problem perspectives. Elie seems to perceive colloquial Arabic as a right for learners to be able to talk about their mathematical ideas, and seems to recognize English as a problem. He encourages learners to use Arabic, "In Arabic if you want. Don't worry about English. You have to speak up. We can barely hear your voice" (session 1, turn 146). In contrast, Nour seems to think that learners have the right to learn to use French in mathematics and she seems not to consider French as a problem. This is manifested in the dominant use of French in her class interaction.

More research is certainly needed in multilingual mathematics classrooms to reinforce the current findings, to analyse other features of the role of colloquial Arabic in teaching and learning algebra, and to enhance methodological tools. There is a lot of research to be done in the Arab world and other multilingual countries in order to understand the profits and challenges of teaching mathematics in a foreign language, particularly for learners from low or middle socioeconomic status.

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Teachers' use of language in multilingual mathematics classrooms during trouble-spots

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Mathematics teaching in a foreign language may lead to discrimination for some learners specifically during trouble-spots that require the construction of shared-understanding. This study explores the association of language use and patterns of interaction between teacher and learners during trouble-spots in two grade seven multilingual classrooms of Lebanon where mathematics is taught in a foreign language. The study compares and contrasts classroom teacher talk for learners from low or middle socioeconomic status. One of the classrooms is located in a public school in which French is the language of instruction, and the other classroom is in a private school in which English is the language of instruction. Eighteen lessons were recorded and transcribed, and utterances of teacher and learners were coded at the levels of: school; session; interlocutor; language use; move and function. Quantitative analysis of interaction and language use and qualitative illustrations of representative sequences are reported in this article. The triadic dialogue as the dominant mode of interaction and the multilingual nature of language were found as unique aspects of classroom teacher talk. Quantitative analysis shows that the teacher in the private school intended to scaffold learners' reasoning with mixed languages (colloquial Arabic and English), whereas the follow-up moves for the teacher in the public school were dominantly associated with French language with limited use of colloquial Arabic. Qualitative illustrations indicate that conceptual and procedural-inquiry knowledge types characterized the discourse elicited in the mixed-language dominant classroom, whereas factual and procedural-algorithmic knowledge were dominant features of discourse in the French dominant classroom. Furthermore, the practices in both classrooms indicate that the two teachers view language as a resource. Nevertheless, differences in the roles of language as a resource for meaning-making were identified. The teacher in the public school was more likely to use colloquial Arabic to manage the flow and structure of the discourse. The teacher in the private school was more likely to use colloquial Arabic to refer to 1) deictic means; 2) adverbs of generative action; 3) pronouns; 4) calling out numbers and operations; 5) copular verbs in addition to other usage such as affirmation, negation, and request for justification or to request other strategies or for management. The findings of this study are discussed within sociocultural and ethnomethodological views of language as a medium to achieve mathematics teaching and learning of algebra.