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Discourse Analysis of Interpersonal Meaning to Understand the Discrepancy between Teacher Knowing and Practice

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As is well known, bridging teacher knowledge or learning with practice is not a straightforward task. This paper aims to explore this discrepancy between a mathematics teacher's knowing and practices and to offer ways of alignment between the two based on the social/interpersonal meanings and their realization through teacher's discourse. In this study, we utilized discourse analysis of interpersonal meanings within a high school mathematics class mainly by focusing on the mathematics teacher's discourse. We have found that an interpersonal meaning manifested by teacher's discourse establishes counterproductive social roles and relationships for the knowing/learning to come alive. We conclude that the realization of interpersonal meanings can hinder or support the generation of ideas within the classroom: both for teacher's knowing and student's mathematical meaning making.

Keywords: discourse analysis, interpersonal meaning, mathematics education, teacher discourse, teacher practice

INTRODUCTION

Bringing teacher learning into action where the teacher carries own learning into practice is reported to be problematic for many cases of teacher learning. Besides, there are also many different conceptions of teacher knowledge and its relation to practice designate teachers to different roles as learners like consumers of knowledge, inventors of what is known or agents of change (Cochran-Smith& Lytle, 1999). From the socio-cultural perspective, teacher learning is seen a process which is conceptualized as a learning of practicing *professionals knowing in practice*, where *knowing* is collectively generated among all participants (i.e., students and teacher) of the lesson and is "socially shared and distributed across participants and resources" (Kelly, 2006, p. 510). In order to bridge learning and practice, socio-cultural perspective offers an image of teacher expertise depending on the social

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practices that teachers engage in; that is, working and learning cannot be separated (Lave, 1996) and the discourses they produce define and reshape these social practices they participate into (Sfard, 2008).

The above perspective is shared by social semiotics focusing on how people construct their meaning systems and produce meaning as a process of social interaction (Chapman, 2003). This approach particularly matches with *Systemic Functional Linguistics* (SFL) theory theorizing language as a social practice where meanings are exchanged in interpersonal contexts (Halliday, 1978). Through this functional perspective discourse is defined basically as 'language in use' and we 'use language' as among many other semiotic systems to make particular meanings in social contexts (Lemke, 2003).

In this paper we aim to explore this discrepancy between teacher's knowing and practices and to offer ways of alignment between them based on the social/interpersonal meanings and their realization through teacher's discourse. The teacher in our case had conducted an inquiry of own practice for 8 months where she did not exhibit any knowing about her practice for the first 5 months (Celebi Ilhan& Erbas, 2016). Soon after she declared a new understanding about participation into the mathematical classroom (practice)where she noted that she did not actually listen to her students for years and she should reconsider her role regarding listening to the students and to increase student participation. However, this knowing could not be traced in her classroom practice during the initial months and could only be traced partially at the remaining of the study. In this context, we argue that teacher knowing and how this knowing comes to practice is closely related with the process of realization of interpersonal meanings within a strand of teacher's discourse: social discourse. These meanings are generated through the interpersonal meta function of language whose role is to establish social relations between the participants of the discourse (Halliday, 1978). The negotiation of interpersonal meanings is found to be related with negotiating the difference in ideas (Hasan, 2001). We present analyses of classroom excerpts that show teacher realized interpersonal meanings resulted with a non interactive classroom discourse. Furthermore, we show results from the analyses of teacher discourse where the realization process of interpersonal meanings establishes counterproductive social roles and relationships for the knowing/learning to come alive (to be put into practice) to be generated for, shared and distributed among all participants of the discourse. We also discuss how teacher's use of voice hinders the exchange of information between her knowing and her practice about participation.

State of the literature

- SFL theory elaborates on the social processes of meaning making and concerns the use of language to make meanings within discourse.
- SFL research has been used to illuminate various ways to generate mathematical meaning in the classroom, mainly dealing with three functions of language/ meanings within generated within discourse: ideational, interpersonal, textual.
- Generation of interpersonal meaning which is related with how social relations established is found to be closely related with the generation of ideational meanings/ideas/knowledge (i.e., content related meaning) in a certain context.

Contribution of this paper to the literature

- By drawing on the SFL approach, we mainly focus on how people construct their meanings and produce them as a process of social interaction.
- We explore a familiar problem of the discrepancy of teacher theory and practice in terms of the interpersonal meanings realized by the teacher discourse within a mathematics classroom.
- We argue that interpersonal meaning is a window to understand how teacher's knowing is reflected in practice. Result categories are interpersonal meanings within teacher's discourse supporting/ hindering the way teachers knowing to come to practice and the production of the mathematical meanings in the classroom.

THEORETICAL FRAMEWORK

Our work relies on the premise of SFL that language is a social practice where meanings are exchanged in interpersonal contexts (Halliday, 1978). Elaborating on the social processes of conceptualization, SFL theory concerns with the use of language to make meanings within discourse and how meanings were influenced by the social situations. Halliday (1978) introduces three functions of language which have different kinds of meaning potentials: Ideational, interpersonal and textual. While ideational meaning is related to how language is representing one's experience, interpersonal meaning is about how we act upon one another through language and the textual meaning is about how language is organized in relation to its context.

There are SFL based programs for supporting in-service teachers for making discipline specific literacy more negotiable for students who, mainly, are English language learners (Gebhard, 2010). One example is Achugar, Schleppegrell, and Oteíza's (2007) collaboration with teachers in order to analyze the academic language demands placed on students where the teachers planned lessons incorporating SFL tools. They found that this approach led teachers to more in-depth discussions about and understanding of disciplinary knowledge and associated language practices for language learners in particular. There are also critiques of SFL based teacher education programs. They are found to be too technical to implement and might lead to a mere replication of a study of texts rather than critically analyzing discipline specific knowledge/discourses (e.g., Gebhard, 2010). Yet there is a need for teachers to be more aware of the language practices about their discipline and help students to communicate with these language practices while they are learning about this discipline (McCarthey, 2008). Particularly for the mathematics education research, SFL theory enables to examine how mathematics discourse is constructed through language and other semiotic systems and how language and other semiotic systems are used in the construction of mathematics specific meanings (de Oliveira & Cheng, 2011). In particular, SFL research has focused on the nature of mathematical language (Halliday, 1978), mathematical discourse in the classroom and different knowledge structures that the students and teachers display in their classroom talk (e.g. O'Halloran, 2000; Huang, Normandia, & Greer, 2003, 2005) and the interpersonal relationship established in mathematical discourse (Herbel-Eisenmann, 2007; Morgan, 2005, 2006; O'Halloran, 2004). For instance, Morgan (2005, 2006) focused on the construction of interpersonal meanings and how they may affect the perception of the nature of mathematics by the students and position students in certain ways. She found that certain linguistic choices made in the classroom introduce the information as given, hinders agency, and thus the mathematical ideas are presented as not to be actively engaged. Accordingly, as part of a lesson study, Zolkower and de Freitas (2010) explored mathematics teaching, learning, and learning to teach from a social semiotics perspective where classroom texts were analyzed by beginning mathematics teachers using SFL tools. They found that guided deconstruction of texts has a great potential to increase teacher's awareness of the semiotic choices available to jointly construct the mathematics in the classroom with their students and their choices affect their students' mathematical meaning making. Moreover, the format of mathematical texts in the textbooks is also found to be creating roles and positions for the author and the readers (Herbel-Einsenmann, 2007).

In addition to the SFL theory's conceptualization of it as a social semiotic resource, language is also an important means of communication. The whole teaching and learning taking place in the classroom can be seen as a communicational act where the teacher's discourse or his/her use of language is a significant resource that sets the social and roles and relationships between the participants of the mathematical classroom discourse. Boaler (2002, 2003) describe good mathematical classroom discourse and argue that within such a discourse students take initiative, to demonstrate human agency and they use "I voice" about language and mathematics when participating in the classroom discourse. Similarly, Wagner (2007) states that the teachers make students to get an increased sense of human agency while doing mathematics by providing students with the opportunity to develop in expressing agency in mathematical language where in order to that they will need to hear their teachers to use expressive voice (i.e., the "I voice") in their mathematical practice. Through examining the dynamics of social relations in multiparty conversations like professional collaboration settings, Spicer (2011) showed power relations can sustain or maintain the realization of interpersonal meanings where it goes in accordance with the development of ideas (i.e., knowing/learning). Bernstein (2000) also addressed control and power as pedagogical devices where the former deals with the forms of communication and the latter deals with the forms of classification as distinctions between approved categories of meaning. Thus, teaching and learning of school mathematics as communicational acts is closely related with the above mentioned mechanisms.

The social semiotic perspective argues that constructing collective meaning about actions and ideas is bound up with negotiating interpersonal meaning (Spicer, 2011). That is, the generativity of ideas depends on the generativity of the social relations (Hasan, 2001). Such generative co-construction of ideational and social relations exemplifies what Vygotsky (1978) described as a developmental process "deeply rooted in the links between individual and social history" (p. 30).

As part of a longitudinal study of teacher learning in and from practice lasted for 8 months the participant teacher of this study inquired her own practice and she declared that she learned about new ways of participation into the mathematical practices in the classroom for all participants of the discourse. The first time she talked about her knowing was around the 5th month of the study. However, we did not trace this knowing was brought into action until the end of the study or at least she only did that partially. We also found her statement about *new forms of participation* as significant in line with the research tradition viewing individuals learn through a process of participation in the social interactions of a classroom. (Sfard, 2008; Vygotsky, 1978; Yackel & Cobb, 1996). From this point forth, for the research reported in this paper, the research question is "what do interpersonal meanings tell about the discrepancy between the teacher's learning (knowing) and her own discursive practices in the classroom?"

METHODS

The participant

Mary (pseudonym), a secondary mathematics teacher, was the sole participant of this study. She had 19 years of experience as a high school mathematics teacher and had been working at the same school for the last eight years at the time of data collection. At the time of data collection, she was teaching both geometry and mathematics courses and reported that she was experienced at teaching both. Her overall mood in the classroom was calm, friendly yet distanced and authoritative. Located in a large urban district, the school had 84 teachers and 1,394 students, with an average class size of 40 students. Mary was selected as the participant in aforementioned larger study based on her willingness, being considered as an experienced teacher, having participated in professional development or training activities before, and having a clear desire for professional development and learning. She has participated into PD activities provided by the Ministry of National

Education such as measurement and evaluation seminar, generic information technologies course, total quality management seminar and so on. These PD activities were not directly related with mathematics or mathematics education and that she did not participated voluntarily but because the participation was required.

Data collection

As part of a larger study of 8 months where Mary conducted an inquiry into her own mathematical practices data was collected through videotaped observations conducted once every two weeks, monthly audio taped interviews, and the researcher's field notes. There were six monthly audio taped interviews conducted through reflecting upon the selected episodes from videotaped observations that included critical incidents (i.e., the communicative situations where there were moments of tension, conflict, or consensus among the participants) from the lessons. Instances from videotaped observations were determined as critical by either the researchers or the teacher herself. During the interviews, Mary was also revising and rewriting her monthly objectives as the final step for the inquiry process she was conducting on her own. Taking this step, Mary was expected to reflect on in order to elaborate on what had happened and why, based on her monthly objective(s) on her main theme of inquiry.

Observations took place in Mary's 11th grade geometry and mathematics classes. There were about 40 students in each of the classes observed. Through the classroom observations we have focused on the teacher's discourse within the lessons. The teacher's discourse here refers to the teacher's talk and action during her mathematical practice in the classroom. For this study, we have reported on the observation data among the lessons in the second semester since the lesson selected was dated after the teacher declared she had learned about new ways of participation into the discourse. After a while she claimed that assigning students a teaching role would be an effective means to increase student participation into mathematics classroom discourse. Then she had chosen a student and assigned her a teaching role selected for this study. We have chosen this lesson data as we find it significant for our investigation of the dynamics of social relations in multiparty conversations as such in terms of realization of interpersonal meanings. We have also taken field notes to capture our voices as researchers, to make sense of our own beliefs and possible biases during the observations. Credibility and reliability of our results and interpretations were established through prolonged engagement in the field and member checking with the teacher where she did not require any change or revision.

Data analysis

In order to analyze the interpersonal meanings within the teacher's discourse at the mathematics classroom we first transcribed the lesson chosen for the classroom observation. In line with the purpose of the study to investigate the manifestation of the interpersonal meanings we mainly drew upon the SFL and focused on the teacher's discourse in the text. Since interpersonal meanings are related with the interactivity of language (Muto-Humphrey, 2010). The tools we borrowed from SFL were speech functions (questions, statements, and commands), grammatical forms (interrogative, declarative, and imperative), and the congruency as the alignment between the grammatical form and its speech function at the teacher's discourse. By utilizing these tools, we aimed to reveal the participant's positioning, roles, and relationships formed by the choices of language and the use of voice as realizations of interpersonal meanings in and through her discourse. Thus, we first explored the interactivity in the text. For the analysis of interactivity of language, we examined participant's relative positioning as the relationship between the teacher and students as participants of the classroom discourse. For determining the participant's relative positioning, we analyzed the text of the episode in order to understand who provided or received the information within the lesson in general. From this point on we focused on the speech functions that help meaning to be achieved through the use of statements, questions/offering, and commands. Each text contains relationships between the providers and the recipients of the information. Functions of speech such as declaration to exchange information (statements), offering/asking information (questions), and demanding service (commands) are located in every language but they are realized by our deliberate language choices (Haratyan, 2011). After identifying the speech functions of the utterances from teacher's discourses, we have also identified the grammatical forms associated to these functions (i.e., statements, questions, commands). The uses of grammatical forms are as patterns of language that realize interpersonal meaning (Zolkower & De Frietas, 2010). We then examined the congruency between the function and the form of the speech since there may exist statements that are actually in the forms of the questions, vice versa (e.g., Am I clear now?). Secondly, we have also considered the social roles and relationships seen in the text of the teacher and students mainly focusing on the teacher's discourse regarding the issues of social status and power, their degree of alignment when while they are sharing or exchanging information (Muto-Humphrey, 2010). For that, we have examined the use of modal words such as might/may, will/perhaps and must/certainly for the teacher's discourse since different realizations of the speech functions within the teacher's discourse would change the meaning and the relationships between the participants of the classroom discourse hence the interactivity of the text. More specifically, we focused on the use of modals by the teacher for the analysis (e.g., can, may, will, must). Finally, we explored the use of voice in the text to understand "who has control over the mathematics done and expressed" (Wagner, 2007, p.36) within the classroom. At this final step we aim to unfold the discrepancy between teacher knowing and practice through teacher's use of voice.

RESULTS

Interactive positioning

The following excerpt is from Mary's 11th grade mathematics lessons recorded soon after she declared that she had a new understanding of participation to the classroom discourse during her inquiry of own practice.

1 Mary: We will do this lesson with our friend here [referring to Student 1whom was presenting and leading the lesson] and our topic is arithmetical sequences. Let's write our topic and our friend will have us to write down the definitions and *you* will be solving the examples together and will be asking what you did not understand to her.

2 Student1: Sequences which has a constant difference between its consecutive terms is called arithmetical sequences. Write down the formulas too, fellows.

3 Mary: Can you write a bit bigger? and write on the left hand side. It is the general term of arithmetical sequence.

4 S1: [while writing] Let me give an example right away.

5 Mary: OK, does everyone know a_1 among the symbols we used here ? What was it?

6 Students [Chorus]: The first term!

7 Mary: What was d? We did not tell. In some textbooks it might be written as r instead of d. We will say that, the common difference in the arithmetic sequences but the common factor in the geometric sequences. And 'n – 1' denotes that it is the preceding term of a_n.

8 S1: And r is used generally in geometric sequences.

9 Mary: In some resources those are both called as r. If you use them separately I think it will be better you won't mix them up.

10 S1: The general term of a sequence whose first term is 3 and the common difference is 4 asked. *We can do it like that*[*italics added for emphasis*]. First term is 3 and the common difference is 4.By the formula a_n is equal to a_1 is 3 and $3+(n-1).4$ which means $3+4n-4$ is equal to $4n-1$.

11 Mary: OK. Do you think is there any difference between an arbitrary sequence and the arithmetic sequences we have seen until that?

12 S3: There is.

13 S4: Of course!

14 S5: There is. *We* have said that it increases constantly.[*italics added for emphasis*]

15 S6: The difference between the consecutive terms is constant.

16 Mary: What did your friend say when defining? There is a constant difference between consecutive terms which is d. I can therefore…. . If I know an arbitrary term and d, for example it gave the 3rd term and d. How can I find the 25th term?
[*Silence*]

17 S5: 25 is equal to $22d+a_1$.

18 Mary: Now, since I knew the 3rd term, by adding *d* on it *I can find* the 4th term, by adding one more *d* I can find 5th term and by adding another d 6th term. *You can move* like that if the difference between the terms is small. In cases of such as, 25th term or 125th term *we have to use* the general term formula.[*italics added for emphasis*]

19 S1: The 18th term of an arithmetic sequence is 45 and the 8th term is 15. What is the 5th term? [*Solves by applying the d formula in order to find d and then she uses the general term formula to find the 5th term*].

In this excerpt about arithmetic sequences, we observe that Mary was using a variety of speech functions. She mostly used statements and questions and less commands as presented in Table 1. However, students did neither use any form of questions nor commands in their participation to the classroom discourse. In fact, they mostly remained silent. Although student S1 undertook the position of teaching in that lesson, she did not ask any questions and her discourse was mostly in a declarative form (see lines 2, 4, 8, and 10). The only exception for this was her first words about presenting a definition for arithmetic sequences as command directed

Table 1. Interactive positioning in the first part of the lesson

	Statements	Questions	Commands
Teacher	• Topic of the lesson S1 will be leading and have others to write down (line 1) • The formula of the general term of the arithmetic sequence (line 3) • "d" as a symbol of the common difference of the arithmetic sequences (line 7) • The pattern of that the terms of the arithmetic sequences have: (line 16) • Finding any term of an arithmetic sequence(line 18)	• What does a_1 denote as a symbol? (line 5) • What does "d" denote?(line 7) • What did your friend say when defining?(line 11) • Do you think there is any difference between an arbitrary sequence and the arithmetic sequences? (line 11) • How can I find the 25th term? (line 16)	• Write our topic, Solve exercises, and ask what you did not understand to her! (line 1) • Write bigger. (line 3) • Use the general term, the formula! (line 18)
Students	• It increases constantly (line 14) • Difference between the consecutive terms is constant (line 15) • S1: *r* is used generally in geometric sequences.(line 8) • S1: By the formula, a_n is equal to… where a_1 is 3, and $3+(n-1).4$ which means $3+4n-4$ is equal to $4n-1$. (line 10)		

to her classmates. In that sense the lesson was not interactive so far based on the one-way flow of information between the participants on the favor of the teacher.

In case of statements Mary first started with presenting the name of the day's topic as arithmetic sequences and giving information that the student S1 was going to be presenting the lesson and the others were going to write down the definitions. She then declared "the formula" that S1 wrote on the board as the general term of the arithmetic sequences. She continued with stating "d" in the formula denoted the common difference in the arithmetic sequences and what "n– 1" was standing for. She then once again stated that the terms of the arithmetic sequence had a pattern (see line 16). Finally she finished with stating a mathematical routine about when to find all terms one by one or to use the general terms formula. Among all the mathematical questions she asked in this excerpt the first one was about what did $a_1$denote for in the formula for the arithmetic sequences. Similarly, the second question was about the meaning of "d" in that formula. Third question was about the difference between arithmetic sequences and the other type of sequences. The final question was about the utilization of the formula on finding any term of the arithmetic sequence by using a given term and the common difference of the sequence. The teacher generally used commands as to inform students about what they were required to do in general as a learner in the lesson (see line 1). The others were not explicit commands since their grammatical forms were different as presented in Table 1.

In case of the congruency, some speech functions can be identified that they were not matching their associated forms in Mary's discourse. Her question forms (i.e., interrogatives) were mostly substituted with commands. For instance, the question form used in line 3 is not a real question but a command which demanded S1 to write bigger. It is also important to note that when this line (see 3) is eliminated from teacher questions in this part of the lesson half of the questions asked by the teacher are self responded (see 7, 16). We also identify some of the teacher commands which are also in the form of declaratives (statements). For instance, looking at the last sentence of the text in 18, we see a command masked in a statement. In fact, we argue that the whole line was in the form of an imperative which we illustrate at the next section.

20 Mary: OK. Now, how do I do that without using that formula? I am not a fan of using too many formulas because you are confused. You know the 18th and the 8th terms. How do you find without using this formula? [*waits for a while*] Can it be done by using general terms formula? Think about for a second. It is OK with the formula but let's write 18th term according to the general term formula. Is a_{18} equal to $a_1 + d17$? Now let's also apply this to the 8th term. [*S1 applies what she says at the board and conducts the operations*]. OK.

21 S4: Could she also associate that with a_8?

22 S5: But, how could she, without knowing *d*?

23 Mary:[*to S4 and S5*] There are two unknowns: a_1 and *d*. [*To the class*] OK. Now by writing these information one under the bottom and using suppression method we can find a_1 and *d*.

24 S6: By a_{18} being equal to $a_8 + 10d$ ...

25 Mary: a_1 plus $17d$.

26 S7: By associating that with a_8.

27 S8: Yes, it also comes from that, teacher!

28 Mary: OK, fine. You show that also. Your friend has got an idea we will share it to you. Tell them.

Here, at the second part of the lesson Mary still used a lot of statements(see 20, 23, 25, 28) nearly in all of her utterances, but less commands (see 20, 28) and questions (see 20) as presented in Table 2. Instead we see that some students (e.g., S4 and S5) began to ask questions as well. Based on this progress, students started to be relatively more active participants. Furthermore, in this part we also see that teacher's power has been started to be distributed among some students just a bit. Questions of S4 and S5 here denoted they neither seemingly generated a meaning of the general terms formula nor the use of it. However along with these questions the statement of ideas regarding the solution (S6 and S7) showed up that has not been considered by the teacher. Then students in a way started to redirect the lesson with their questions and ideas for the solution. Hence the lesson has become interactive at that second part of the lesson. Even though Mary responded to S4 and S5, her statement suspended the interaction among these students and herself. However, in a way, the interaction has been continued by other students who agreed with S4 and S5.

Social roles and relationships as choices of language

As being the one who holds power within the classroom discourse, Mary's choices of language mainly determined the participants' roles and relationships within the classroom. We have identified these choices through the use of modalities in the text. The modalities Mary refers most were located in her statements and her commands.

Modalities chosen by the teacher for this lesson are presented in Table 3. Among these modalities, *will* and *can* are two major types. The function of *will* in her utterances was as statements and commands. Looking closely to the first type of the

Table 2. Interactive positioning at the second part of the lesson

	Statements	Questions	Commands
Teacher	• It is OK with the formula…Let's write 18th term according to the general term formula. (line 20) • There are two unknowns: a_1 and *d*. …writing these information…and using suppression method we can find a_1 and *d*.(line 23) • a_1 plus $17d$.(line 25) • Your friend has got an idea. We will share it to you. (line 28)	• Now, how do I do that without using that formula? it be done by using general terms formula? (line 20) • Is a_{18} equal to $a_1 + d17$? (line 20)	• Now let's also apply this to the 8th term(line 20) • You show that also. Tell them.(line 28)
Students	• By a_{18} being equal to $a_8 + 10d$ (line 24) • By associating that with a_8 (line 26) • Yes, it also comes from that, teacher! (line 27)	• Could she also associate that with a_8 ? (line 21) • But, how could she; without knowing *d*? (line 22)	

Table 3. Teacher's use of modalities

Modality	Sample Sentences	Function
Will	We will do this lesson with our friend. You will be solving the examples together.	Statement Statement/Command
Can	We can find a_1 and d . Can you write a bit bigger? Can it be done by using general terms formula? How can I find the 25th term?	Statement Command Question
have to	We have to use the general term formula.	Command
I think	I think it will be better that you won't mix them up.	Statement.

use of *will* (i.e., "we will do this lesson with our friend") tells us that the teacher was providing information to her students but with a sense of obligation as well. The other type of using *will* in Mary's discourse was for producing command like statements but they hold a strong degree of obligation meaning that students were required to act in certain ways.

There is also a frequent use of *can* in Mary's discourse, in her questions as well as in her statements and commands. When used in a command, *can* reduce the strength of the demand (e.g., *Can you write a bit bigger*?). In Mary's statements and questions it implied a low degree of obligation giving a reference to the mathematics as a discipline as it is permitted mathematically to act in certain ways.

The use of *have to* and *think* were very rare. She only used both once and the way *think* was used (i.e., *I think*) reduced the certainty of her statements and her use of *have to* added a strong obligation to her requests.

Use of voice

As the third category, we particularly analyzed the use of voice in Mary's utterances in this lesson to unfold the discrepancy between her practices and her knowing about participation into the classroom discourse. In the vignette presented above where a student (S1) presented and led the lesson, Mary used different voices while realizing interpersonal meanings in her discourse. She used *we* voice very often combining with the less frequent use of *I* voice. This reflects Mary's domination over the classroom at the ways of doing and expressing of mathematics. In doing that, Mary grounds on an expert *we* voice that includes a collective of mathematicians who are always accurate and right:

> What was *d*? **We** did not tell. In some textbooks it might be written as *r* instead of *d*. **We** will say that, the common difference in the arithmetic sequences but the common factor in the geometric sequences. And '*n* – 1' denotes that it is the preceding term of a_n.
>
> By writing these information one under the bottom and using suppression method **we** can find a_1 and *d*.

This also indirectly called students to come to terms with this voice in a way that limits any kind of discussion.

On the other hand, here Mary uses "I" voice as a way to represent student thinking. When she uses *I* voice she starts an imaginary conversation between her students and herself in which students are not active at all. In fact, most students in the class remained silent and listened to this teacher talk monologue where the teacher thought or and planned to act mathematically on behalf of her students:

> There is a constant difference between consecutive terms which is *d*. I can therefore…. If I know an arbitrary term and *d*, for example, it gave the 3rd term and *d*. How can I find the 25th term?

She also switches from the "I voice" to the "*you* voice" which makes her talk/thinking general as it belongs to an abstract mathematical voice generalizing how and what to do. For instance, in line 3 we find all of these voices together:

> Now, since I knew the 3rd term, by adding *d* on it *I can find* the 4th term, by adding one more *d* I can find 5th term and by adding another *d,* 6th term. *You can move* like that if the difference between the terms is small. In cases of such as, 25th term or 125th term *we have to use* the general term formula.

In the first sentence she used *I* voice where she acted as the person who had to solve the given problem, as being a student. Then, she generalized the way or the pattern for the solution by using *you*, and then switched to the *we* voice to ensure students accepting the use of general formula for bigger terms such as 125th term or so on. Considered together with the use of *will* and *can*, Mary's use of *we* voice makes the utterance of declarations of information to the students whereas *you* voice changes the sentence to a command or a demand from the students which makes students act or talk accordingly.

DISCUSSION

This study reports on a case that a high school mathematics teacher inquiring her own practice declared a knowing (about participation into discourse for her students and for herself) which in a way, is not manifested in her practice. In this context, we have investigated the interpersonal meanings realized by the teacher during her lessons in order to understand the relationship and the discrepancy between the teacher's knowing and her practice. Regarding that purpose what we argue is that interpersonal meaning is a window to understand how teacher's knowing is reflected in practice being related with the social strand of the teacher's discourse.

The analysis of the interpersonal meanings showed that participants were none interactively positioned to each other within the mathematics classroom. Students always remained in the position of providing the information asked by the teacher or by the student who undertook a "teacher role" for the lesson. However, they were actually not receiving any information since they did not ask any 'questions'. As for the teacher, Mary, she had an authoritative power that has an overall control on the students during her lesson. Based on Bernstein (2000), we argue that Mary's use of control as a pedagogical tool clearly limits the forms of communication and her exercise of power was determining which meanings generated by the students should be approved within the mathematical classroom. For instance, at first part of the lesson, there was actually no interactions in the sense that students participate in the production of any mathematical discourse (i.e., in terms of talk and/or action) but they passively receive and follow the information Mary told them (see Table 1). However, in the second part of the lesson students (S4 and S5) suggested a solution strategy other than teacher's initially ignored by the teacher (see Table 2). Further this meaning associated with a_{18} has provoked other students to think about the 'other way'. Even this short instance shows how the realization of interpersonal meanings through the reorganization of social roles and relationships and the interactivity among the teacher and the students allowing for and supporting the students to generate new ideas and meanings within mathematical classroom. On the other hand, Mary was also assuming that changing the roles and relationships between herself and her students would change the forms of participation to the mathematics classroom discourse. During an interview, Mary's interpretation about this lesson was that individual students' undertaking teaching role would increase student "participation". Yet, the way teacher realized interpersonal meanings, restricted communication and interaction bounded by social roles and relations within the classroom where "equality of participation (…)[is] an accomplishment of any interaction" (Spicer, 2011, p.3).

Mary's use of voices in doing mathematics also shows that she frequently called on "we" voice referring to the collective of mathematicians who are the voice of convention (Wagner, 2011) and a "you" voice when trying to generalize and using it like a comment to act in a certain mathematical way. However, Mary's rare use of the "expressive I" voice is, as in line with Boaler (2002, 2003), had given the audience (her students) a sense of mathematics which is independent of human agency where most of the time students did not take initiative to participate in the "doing of mathematics" in the classroom. Hence, domination of the teacher's "expert we" voice and "general you" voices within the classroom discourse limited student's agency to make mathematical meaning making. Even with the presence of a student making his/her presentation the others, students' position stayed the same; that is, receptive but not participative and not taking initiative to use their expressive voices. The position of the student presenter in fact was an imitation of the teacher's general position within the classroom.

In light of the findings we can conclude that the way that social relations were established by the teacher through her discourse were closely related with the development of ideas within the mathematics classroom. These ideas comprised of both Mary's knowing about practice, for instance about participation into mathematics classroom (practice) and her students' mathematical ideas. In Mary's classroom, the norms or rules of learning and doing mathematics requiring students to act in certain ways in the classroom was established via a series of interactions between students and herself. During these interactions different kinds of meanings (i.e., mathematical, social, and pedagogical associated respectively with ideational, interpersonal, and textual meanings in SFL) were made within and through the teacher's and students discourse. The generation of these meanings and their manifestation in practice were closely related with the teacher's realization of the interpersonal meanings in discourse. Accordingly, Mary has declared, after 5 months that she had a new understanding regarding the participation into the mathematical classroom (practice) that had implications for both students and herself. However, the establishment of social relations within the mathematics classroom is related with the interpersonal meta function of language (Halliday, 1978) and the negotiation of interpersonal meanings is related with negotiation of ideas (Hasan, 2001). Mary's newly generated idea was limited by the social aspect of her discourse and thus her learning could not be manifested in her classroom practice. She used a declarative discourse based on frequent use of statements and imperatives/commands positioning participants non-interactively in her lessons. She frequently used commands that sometimes masked in the form of statements. In fact, whenever the number of the teacher commands and questions decreased, students started to ask asked more questions and became more active participants in the lesson. Moreover, the analysis of the teacher's choices of language in terms of the social roles and relationships revealed that the teacher's statements were not flexible and not negotiable as being the ultimate authority within the classroom. There was no informal/casual use of vocabulary as there was not any sign of intimacy in the teacher's discourse. Although there was a low degree of obligation (i.e., by using *can*) in some of her statements, she still determined the way that her students acting mathematically.

It might be argued that studying the conflict between the teachers' learning and practice should be relying on a longitudinal study providing richer data sources in order to reach plausible conclusions. However, focusing on how interpersonal meanings realized in even one mathematics lesson reveals a considerable line of thought on why might mathematics teachers do/can not actually put their new ideas/ knowing that came in and from own practice back into their practice. We believe that the potential of the approach in this study lies within its drawing attention on the choices teacher's make through the language that they use within their classrooms Accordingly, in doing that this study also contributes to SFL based teacher education. In keeping with Gebhard (2010), the results of this study shows us new ways to support both teacher educators' and teachers' to become aware of the language practices about the disciplines; thus teachers to find multiple ways for helping their students to communicate with these language practices. It is needless to say that conducting a research covering a series of lesson observations would be beneficial for the researchers and teacher educators to gain a deeper understanding about the role of the realization of interpersonal meanings in student's mathematical meaning making process. It would be also beneficial for the mathematics teachers to participate in deconstructing and reconstructing their own discourses produced within their classes in terms of interpersonal meanings as a way of professional development based on social semiotics and SFL theory (Zolkower & de Frietas, 2010). However, to utilize this SFL based/ social semiotic approach as a PD opportunity, researchers should direct teachers' attention on possible ways to guide student's processes of meaning making. This is crucial to enhance student's "meaning potential" and help them to produce their own mathematical narratives (i.e., to learn about mathematical theories and definitions) which are among important aims of school mathematic (Sfard, 2008). In doing that, a group of teachers can be formed to watch videotaped lessons and deconstruct each other's discourses during teaching in order to find ways to support student's participation into the making of mathematical meanings. This might also be useful for teachers to learn about the obstacles and complexities to foster such a discourse that allows their students to develop their own discourses for thinking and doing mathematics.

In this study, we also grounded on the ideas that teacher learning is shared among all participants and that the resources available within the classroom (Kelly, 2006) and social semiotics that generating meanings, ideas, and actions are closely related to the social interactions (Chapman, 2003) within discourse. We also draw on Spicer (2011) arguing that the relations between ideational/ or content and interpersonal/ social metafuntions of language are co-constructed generatively based on Hasan (2011). Based on these ideas, we mentioned above we believe that the results of this study can be a window for understanding the conflict between teacher knowing and practice. Keeping up with Spicer (2011), we concluded that the teacher realized (interpersonal) meanings can show us how establishing social relations between students and the teacher within the mathematics classroom would support or hinder teacher knowing to come into action as well as students' generation of mathematical ideas. We believe that what goes in the mathematics classroom as a discursive and communicational practice cannot be fully understood without considering the social relations between the students and the teacher as relations of power (Bernstein, 2000). A future research exploring the negotiation of social relations together with the relations of power in the mathematics classroom might be valuable in order to resolve the complexities of teaching mathematics to support the development of student thinking within school contexts.

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