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Examining pedagogical and classroom discourse through the lens of figured worlds: The case of an elementary school teacher

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The problem solving approach to teaching and learning mathematics has for some time been the focus of professional development (PD) programs. This paper discusses a case study of an elementary school teacher who participated in such a program. We apply the lens of figured worlds when analyzing her pedagogical and classroom discourses to reveal which aspects of explorative figured worlds penetrate her discourse. Findings indicated that the teacher adopted some aspects of explorative figured worlds but resisted others. The lens of figured worlds can help us, as teacher educators, to plan continued PD.

Keywords: Figured worlds, explorative instruction, professional development.

Introduction

Although there is a consensus among researchers and teacher educators regarding the benefits of what may be called explorative instruction (i.e., inquiry-based, student-centered, and cognitively demanding instruction) (Schoenfeld, 2014), studies have shown that teacher-centered, ritual instruction is still very prominent in many classes (e.g., Resnick, 2015). Resistance to explorative instruction may even be found amongst teachers who have taken part in professional development specifically promoting this type of instruction (Heyd-Metzuyanim, Munter, & Greeno, 2018). One way to explain this phenomena is by viewing it through the lens of ‘figured worlds’ (Holland, Lachicotte, Skinner, & Cain, 1998). Figured worlds are based on one’s interpretation of situations and may be revealed through discourse.

This paper presents a case study of one teacher, Yifat (a pseudonym), and analyzes her pedagogical and classroom discourses after participating in a professional development (PD) program centered on problem solving and explorative instruction. Through the lens of figured worlds, we analyze her discourses and examine which aspects of explorative instruction she adopted and which were missing.

Theoretical background

This section begins by offering some background on the notion of figured worlds and how it relates to mathematics education. It continues by describing the problem solving approach to teaching mathematics. Finally, as this paper analyzes the teacher’s pedagogical and classroom discourses, the section ends by presenting how discourse is understood in the commognitive approach.

A figured world is defined by Holland and her colleagues (Holland, et al., 1998) as “a socially and culturally constructed realm of interpretation in which particular characters and actors are recognized, significance is assigned to certain acts, and particular outcomes are valued over others” (p. 52). People ‘figure’ out who they are through the activities of their world, in relation to the

social types that populate these figured worlds, and in social relationships with the people who perform in these worlds. In addition, artefacts and signs are attributed meaning that might differ from how those outside of the figured world interpret them. To sum up, the people within the figured world take on roles that come along with responsibilities, and in addition, certain actions, outcomes, and objects are valued more than others.

Relating figured worlds to mathematics education, Boaler and Greeno (2000) pointed out that the difference between ritual and explorative instruction may not just be a matter of certain teaching techniques or forms of classroom organization, but a matter of widely different figured worlds. They defined the problem-solving, group-work mathematics instruction found in some secondary schools as a “connected knowledge” figured world. In contrast, the more common teacher-centered instruction was conceptualized as a figured world based on “received knowledge”. Ma and Singer-Gabella (2011) showed that it was difficult for prospective teachers to move from the “traditional” figured world (in which they supposedly studied at school) to the “reform” figured world of mathematics instruction, supported and enacted in their training program.

Over the years, evidence has shown that the “connected knowledge” figured world is fruitful for mathematics learning (Schoenfeld, 2014). In particular, Hiebert and Grouws (2007) highlighted two significant aspects of such teaching: Explicit Attention to Concepts (EAC), and Students’ Opportunity to Struggle (SOS). These two aspects are part of the problem-solving approach to teaching mathematics (Hino, 2015). This approach emphasizes meticulous planning of detailed mathematics lessons that include implementing rich problems in such a way that students are active participants who explore mathematics. The teacher’s role is to create learning opportunities that support students’ conceptual understanding through problem solving, as well as supporting student agency and authority (Schoenfeld, 2014). Relating to all of the above, Shabtay and Hed-Metzuyanim (2018) described the figured world of exploration as one where students are free to struggle, mathematics is at the center, and the teacher and students share responsibility for the learning process.

Learning, including learning mathematics, may be seen as the process of becoming a full participant in a certain discourse (Sfard, 2008). Such participation may be characterized as lying on an axis between ritual and explorative participation (Viirman, 2015). In Sfard’s commognitive framework (Sfard, 2008), a basic assumption is that doing mathematics means engaging in mathematical discourse. Discourses, according to Sfard, are different types of communication “set apart by their objects, the kinds of mediators used, and the rules followed by participants, and thus defining different communities of communicating actors” (p.93). While these discourses are not stable or distinct, but rather overlapping and constantly developing, it still makes sense, within a given context, to see them as “distinct enough to justify talking about discourses [. . .] as reasonably well-delineated wholes” (p. 91). Regarding the classroom as a community, Tabach & Nachlieli, (2016) defined a pedagogue, as a person who assumes the role of the leading participant in the discourse. Thus, pedagogical discourse is a discourse about teaching and learning (Shabtay & Heyd-Metzuyanim, 2017). Similar to any other discourse, it is made up of certain key words, narratives, and meta-rules that dictate what to teach students, how to teach them, and who can learn (or not

learn). This view is based on Sfard's (2008) view of mathematizing as participating in a discourse about mathematical objects. The pedagogical (the how and for whom) is closely intertwined with the what (Shabtay & Heyd-Metzuyanim, 2017).

Through the lens of figured worlds, this study examines which explorative narratives may be found in a teacher's classroom discourse and in her pedagogical discourse, after participating in a PD program focused on the problem solving approach to teaching mathematics.

Methodology

Yifat is an elementary school teacher with a B.Ed. degree and a specialization in mathematics. At the time of the study, Yifat had 11 years of experience teaching mathematics to fourth and fifth graders (10-11 years old), and was the mathematics coordinator in her school. This case was chosen because it illustrates the gap between a teacher's classroom and pedagogical discourses. In addition, Yifat consented to be part of the study, and agreed that her lesson and interview be recorded.

Yifat participated in a PD program for mathematics teachers centered on designing and implementing lesson plans according to the problem-solving approach (Hino, 2015). During the program, teachers engaged in cognitively demanding tasks, viewed videoed lessons demonstrating the problem solving approach, discussed the pedagogical gains and mathematical ideas that emerged from those lessons, and designed lesson plans modeled on the problem-solving approach. The PD program took place over a period of eight months, and included 10 sessions. In addition, each teacher met with the PD educator three times on an individual basis, receiving personalized instruction and advice for planning and implementing mathematics lessons using the problem-solving approach in their specific classes.

Relevant to the present study, the seventh meeting of the program dealt with the construction of prime and composite numbers. During that meeting, teachers, including Yifat, engaged with a cognitively demanding task that involved representing different prime number with different signs, and composite numbers with an appropriate combination of prime number signs. For example, a card representing the number 2 had a circle on it, the card for 3 had a triangle, and the card for six had both a circle and a triangle (see Figure 1 for the symbols which represented the numbers from one to ten). During the session, teachers also viewed a Japanese lesson, demonstrating how this activity may be implemented as part of a problem-solving teaching approach to learning these new concepts. At the end of this session, Yifat invited the teacher educator to come to her fourth grade class and observe her teaching this exact lesson. Yifat expressed her belief that she "finally understood the problem-solving approach," and that she felt students would enjoy the lesson and experience meaningful learning.



Figure 1: Cards with symbols representing the numbers from 1-10

Data collection and analysis

Yifat was interviewed both before and after the observed lesson. The first interview dealt mainly with the goals of the lesson, the main mathematical ideas, and the planned pedagogical processes. The post-teaching interview revolved around achievement of goals, class-driven processes, and the mathematical ideas that emerged from students and the teacher during the discussions. Each interview was audio-taped and transcribed. The lesson was video-taped and transcribed.

Relating back to the theory of figured worlds described previously, a qualitative analysis was carried out on all transcriptions searching for four dimensions of figured worlds: characters, valued actions, outcomes, and artifacts. The characters, in this case the teacher and students, play roles that involve responsibilities. Thus, when analyzing characters, we analyze the roles Yifat plays and those she refers to during her interviews. Noting the value that Yifat places (or does not place) on these four dimensions, we describe Yifat's figured world and compare it to an explorative figured world.

Findings

In the transcripts below actions are underscored with one line, outcomes with a double line, and roles and responsibility are indicated with a broken line. Artifacts are in bold.

The first interview took place in the teacher's classroom, during the recess prior to the mathematics lesson. Yifat was anxious, and yet proud, to show the teacher educator what she had prepared.

Interviewer What's new?

Yifat Hi. (Yifat is preoccupied with **a bag of flashcards**).

Interviewer Do you need help?

Yifat Look. I made these **symbols**. **These (she places the flashcards on the table)**.

Interviewer Okay.

Yifat You'll see. I will arrange it for them after they sort them like this. (She arranges the cards as in Figure 1. She has more cards that have not been arranged yet.)
Then we will discuss the topic. That's okay, isn't it?

Interviewer What are you going to try to achieve today? How would you describe your objective?

Yifat Uh ...That they know what a prime number is, and what a composite number is.

Interviewer Hmm...and how did you plan the lesson?

Yifat You'll see. I planned it just like the teacher in the clip. Don't worry (she is busy with the flashcards, putting them back into the bags)...I need the sticky stuff so that I can stick them on the board (gets up to get the glue).

From the lines above, we see Yifat's preoccupation with the flashcards, signifying their value in her eyes. Yifat also states her intent to emulate the teacher in the film. Emulation is an action that might indicate her tendency towards being a ritualistic learner, i.e., she watched a documented lesson

during a professional development meeting, and would like to replicate the lesson. Thus far, it seems that Yifat has chosen an appropriate problem, and has brought along appropriate props (cards) that will help her achieve the goal of students “knowing” (Yifat’s term) what prime and composite numbers are. Note that she does not relate to explorations and discussions as objectives, or valued outcomes.

The observed lesson was 47 minutes long. The teacher began by randomly sticking the cards on the board and telling the children to decide how the cards could be sorted. Yifat proceeded to spend 30 minutes listening to various suggestions of how to sort the cards, calling on different students to demonstrate their method on the board. Finally, she arranged the cards on the board in ascending numerical order as represented by the symbols, in accordance with her lesson plan (see Figure 1).

For the next 12 minutes, she again led a whole-class discussion, this time relating to the arrangement of the cards on the board. Yifat tried to steer the discussion towards explaining the arrangement of the cards, as depicted below.

- Yifat Let’s make things clear. You (meaning the class) said skip by twos, and Noa just said even numbers (referring to the cards with circles on them). Let’s check everything. Imagine that I have more and more cards. And there’s always a shape. There’s a circle, and another shape, and a circle and something else, and a circle and something else. (Pause) And what’s here?
- Student A (something unintelligible)
- Yifat Here is another circle. And something. I am skipping on purpose. What do you say? Yoav, do you agree with what she said?
- Yoav Yes.
- Yifat Daniel, do you agree?
- Daniel Yes.
- Yifat So wait a second. Let’s make some sense out of this so we can understand what’s going on. Michal said (referring to the circles) that 2 and 2 and 2 and other items were added. And Roni says ... (referring to the triangles) it skips by 3.

In the above segment of classroom discourse, Yifat takes the lead, saying “Let’s make things clear.” Although she takes the lead in the discourse, her use of the word “let’s” hints at her inclusion of the students in the process of making sense of the symbols. She also turns to different students and asks them if they agree, sharing with them the responsibility for learning. Yet, Yifat’s questions are closed yes or no questions. She does not ask those students to expound on their thoughts. Finally, her valued outcome is that we will “understand what’s going on.” During the last five minutes of the lesson, Yifat wrote down the numbers from 1-10 under each of the symbols and introduced the notions of prime and composite numbers. It was only during those five minutes, that mathematics was at the center of the discourse.

In the interview following the lesson, Yifat talked about the differences between this particular lesson and her regular lessons:

“Look, this was a really different type of lesson. They haven't learned composite or prime numbers at all. So, it's the first level of acquisition. And also, it's...the first time that I...gave a lesson like this, when the whole lesson is...um...only the one problem. It's different from what we usually do. They always have a lot of practice, exercises... Here (pointing to the **cards**) ... they are just symbols that you have to categorize...and understand.”

The actions mentioned by Yifat are student actions. In the past, they practiced; in the present, they categorized. Most interesting are the outcomes she values. The outcome of her lesson plan is the “different” type of lesson she perceives as having enacted. The outcome for her students is that they will “acquire” the first level of understanding. The terminology Yifat uses gives us a mixed message regarding her figured world. On the one hand, she consciously attempts to break with her former lesson style. She chooses to implement a cognitively demanding task. Yet, she resorts back to words such as “acquisition,” and “giving a lesson,” that remind us of a traditional figured world.

Asked if she has achieved her goals for this lesson, the following exchange ensues:

Interviewer Okay. So, in your opinion...did you achieve your goal?

Yifat Of course. Look, it's only the beginning, and [so] I had to explain...so...yes.

Interviewer Um...what was your objective?

Yifat That they would know what a prime number is and what a composite number is.
That they would know how to differentiate between the two.

Interviewer Okay. How do you know that they have, in fact, made that distinction?

Yifat Because, look. I told them. They also said that there are **cards with one symbol** **and there are cards with a number of symbols**. ...I'm sure that most of them understood. And whoever didn't, I will sit with them in a small group and explain it again. You know, it's only the beginning. Look. They can't arrive at it by themselves. My job is...I have to explain it to them and that's how they'll know. They would never get to it by themselves.

Interviewer Why?

Yifat Because it's too complex. Later, when things are clarified, I'll be able to let them come up with symbols for 13 or 17, and construct 12 or 18.

The actions Yifat values for herself (e.g., explaining, telling), go hand-in-hand with how she describes her “job”, or role, as an “explainer”. Although during the classroom discourse Yifat did ask students to share their ways of sorting the symbols, during the interview she ascribes a passive role for her students, claiming unequivocally that they would not be able to arrive at the mathematical conclusions on their own. This interview offers evidence that Yifat’s figured world is mostly traditional.

Referring to the main characteristics of the problem-solving approach, Table 1 summarizes the similarities and differences between Yifat's figured world and the explorative figured world. Yifat does choose to present a cognitively demanding in her class. She perceives this lesson as being quite different from those she usually teaches. Additionally, Yifat led a discussion concerning the task she presented to her pupils. These are all part of the explorative figured world. However, Yifat did not offer enough of an opportunity for her students to struggle with the problem. Recall that after she randomly stuck the symbols on the board, she immediately began to call on students to share their ways of sorting, without giving them time to think about it. When she finally arranged the cards in order, she still had difficulty shedding her central role as the teacher who explains, and where the students are attentive. These are elements of a more traditional figured world. In other words, Yifat is struggling between two worlds.

	Explorative world	Yifat's world
Teachers select cognitively demanding tasks	+	+
Students present their own ideas	+	+
Collaborative group discussions	+	+/-
Shared mathematical authority	+	+/-
Students are offered opportunities to struggle	+	-
Explicit attention to concepts	+	-

Table 1: A comparison between Yifa's figured world and an explorative figured world

Discussion

The aim of this study was to investigate what explorative narratives enter into a teacher's classroom and pedagogical discourses after attending PD focusing on a problem-solving approach to teaching. From the first, we get mixed messages. Yifat is very enthusiastic about the task, yet is preoccupied with the artifacts (the cards). Though not entirely insignificant, the cards are actually mere props, to be used in the ultimate aim of having students engage with the concept of prime and composite numbers. Yet, during the lesson, more time is spent discussing the artifacts than on the mathematical concepts they were supposed to elicit; not enough time is allowed for exploring the possible significance of the symbols and how they might be related to mathematics (Hiebert & Grouws, 2007). This is also reminiscent of Henningsen and Stein (1997), who argued that a teacher must not only select and appropriately set up worthwhile mathematical tasks, but must proactively and consistently support students' cognitive activity. In addition, although her classroom discourse shows her attempts at sharing authority, her second interview contradicts this view. These findings are in line with Sfard's approach (2008), that discourses are not stable, but rather overlapping and constantly developing.

While acknowledging that discourses may be overlapping, as teacher educators, we attempt to move teachers toward a more explorative discourse. Sfard (2016) suggested that for teachers to be

explorative in their teaching, they must have experienced explorative mathematics learning for themselves. Yifat had limited experience with this type of learning, most of which stemmed from the PD program. Indeed, Yifat explicitly states that her aim is to imitate the teacher in the filmed lesson. She does not say that her aim is to offer the students the same type of experience she has recently had in the program. From paying attention to her discourse, we might infer that additional time must be given for teachers to experience for themselves explorative learning.

By focusing on characters, actions, outcomes, and artifacts, we can see what parts of a figured world a teacher adopts, and which seem to be restricted. As teacher educators, we can utilize this lens to listen to teachers' discourses and identify aspects that perhaps need more attention. Yifat is ready to adopt appropriate tasks, and willing to listen to her students. At this point, we would say that more attention could be paid to authority, while at the same time placing the mathematics at the center. Insight into a teacher's figured world, can help teacher educators plan appropriate professional development.

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