The discursive routine of personifying and its manifestation by two instructors

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This paper focuses on teaching processes in the mathematics classroom. We adopt Sfard's communicational framework to address the question: What were the teaching actions that seem to promote learning? To address the question, we analyzed four lessons taken from two courses about functions which were studied by elementary-school prospective mathematics teachers. We identified a teaching mechanism that seems to relate teaching to students' learning. This mechanism includes flexible and dynamic transition between mathematizing (talk about mathematical objects), subjectifying (talk about the participants) and personifying (talk about human participants acting upon mathematical objects). We also identified several types of personifying talk.

Keywords: Classroom communication, personifying, teaching routine.

INTRODUCTION

This paper focuses on teaching processes in a mathematics classroom. Teaching and learning processes are interwoven, both enacted concurrently by different participants. Studying both under a similar lens could provide holistic insights about classroom processes. This study is a part of a larger study about teaching and learning, however, here we mainly focus on teaching. Let us look at the following two turns, uttered by an instructor:

> Please look at the board. Ok, here we have a graph that describes a connection between two variables. The question is, what type of questions we could answer using this graph and which questions we cannot answer by this graph.
>
> The *y*, yes, it is always *y* that changes according to *x*, ok? We have y that changes depending on, or according to, *x*, ok?

It is obvious that both excerpts are from a mathematics lesson. This certainty stems from the words used (graph, variables), and the articulation (*y* changes according to *x*). However *look at the board* is a general classroom saying about participants' actions, not specifically related to mathematics.

Indeed, during mathematics lessons we could expect the participants to talk about the participants of the discourse (about the students and teacher, as in: *take out your books*, or *could you please write it on the board?*), or about mathematical objects (*this is a graph of a constant function*). Looking back at the above excerpts, we find that some parts are compatible with this division: *Please look at the board* is about human participants; whereas *it is always y that changes according to x* is about mathematical objects. However, we have other sayings that do not fall under those two categories. Rather, they are at the intersection between the two sets, and relate to both –human participants and mathematical objects: *here* ***we*** *have a* ***graph*** *that describes*... We suggest that this type of teacher's interwoven talk about both - participants and the mathematics is important for students' learning.

To learn more about this phenomenon, we closely examined 4 lessons out of two cohorts of data: transcribed video-recordings of two courses about functions that were studied by elementary-school prospective mathematics teachers. The question we asked: *What were the teaching actions that seem to promote students' learning?*

TEACHING PRACTICES AND ROUTINES

Sfard (2008) has defined the teaching-learning agreement, which is:

> a situation that arises when the discursants are unanimous, if only tacitly, about at least three basic aspects of the communicational process: about which is the leading discourse, about the discursants' own respective roles as those who learn or those who teach, and about the nature of the expected change. (Sfard, 2008, p. 299).

From this we (Heyd-Metzuyanim, Tabach, & Nachlieli, submitted) derive that a pedagogue (teacher or instructor) is a person who assumes the role of the leading participant in the discourse while the student is a person who assumes the position of the follower in the discourse. Indeed, these definitions fit the Greek etymology of pedagogy which is *a person who leads the child*.

In that sense, pedagogy is a particular form of communication, and communication, in turn, is a particular type of activity (Sfard, 2008, p. 296). Combining this view with Cultural Historical Activity Theory (Engeström, 1987; Roth & Lee, 2007), one realizes that the main distinction that can characterize a particular activity as pedagogical is its motive. Leont'ev, Roth and Radford (2011) write: "The chief difference in activities is to be found in the difference of their objects or motives. An object/motive (fishing, for instance) is what endows the activity with a particular intent. But activities involve also actions and specific contextual methods and means to carry out these operations" (p. 6).

Combining activity theory with the communicational definitions, we arrive at the conclusion that pedagogy can be defined as the communicational activity which motive is to bring a change in the learners' discourse towards a leading discourse. Such a definition of pedagogy includes all communicational actions (verbal, non-verbal, emotional, etc.).

Contrary to the common division between content and pedagogy (see Leinhardt & Steele, 2005) we offer an alternative lens – that of dividing pedagogical activity into subjectifying (talking about human participants) and mathematizing (talking about mathematics). Subjectifying is thus a communicational activity which motive is to produce narratives about people while mathematizing is a communicational activity which motive is to produce mathematical narratives. Since pedagogy includes both mathematizing and subjectifying, it becomes obvious that different (and something conflicting) motives can be enacted within the same activity.

In this paper, the instructors of the course are the pedagogues and the teaching actions are the pedagogy. We focus on specific teaching-routines (exchange routines, Leinhardt & Steele, 2005), that seem to promote students' learning. For that purpose we focus on the instructor's talk during whole-class discussions.

RESEARCH QUESTION AND PARTICIPANTS

The research question of the study reported in this paper is the following: *What were the teaching actions that seem to promote students' learning?*

The data for this paper are taken from a project that focuses on identifying learning and teaching processes. The data for the project include transcribed video recordings of two mandatory first-year courses about functions for elementary-school prospective teachers studying at a college of education in Israel. The two courses were similar in their content and goals, and were taught in consecutive years, by two different instructors. Each course included 18 students. All of the students have already learned functions and graphs in high school algebra. The students were all older than 19. They vary in age and background, as well as in the level of mathematics that they studied in high school. The two course instructors (Ellice and Talli), hold a PhD in mathematics education and have been teaching at the college for over ten years.

All lessons had a similar structure: opened by a whole-class discussion, followed by group-work (of 3–4 students). The students then reconvened for a summarizing whole-class discussion. The groups were formed by the students and remained stable throughout the course. All 12 lessons of each of the course were videotaped and transcribed. During the lessons, field notes were taken and students' written work was collected. During group-work, the work of two specific groups, chosen randomly, was recorded and transcribed.

For the study reported in this paper we chose to closely examine 4 lessons out of the 24, 90 minutes lessons,

the first and last in each course (We chose lesson 2 rather than lesson 1, as during the 1st lesson consent forms were distributed, and the study was explained.) The choice to focus on two different courses did not originate in intent to compare the courses, but to allow us to examine whether a certain identified routine is teacher-specific or could be a part of common teaching routines.

OVERVIEW OF ELLICE'S LESSONS

In the 2nd lesson, the students were asked to solve an algebraic task (see Figure 1).

The following is a sequence of the three first structures in a series of structures. How many cubes are needed to build the nth structure?

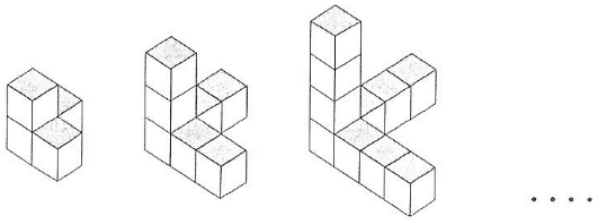

Figure 1: The sequence discussed in class during Ellice's 2nd lesson

While working in small groups, the students were given small cubes to build the structures and answer a sequence of sub-questions aimed at guiding them towards the generalization of the pattern. They then reconvened to discuss the task.

As early as this 2nd lesson, students talked about various representations of the mathematical task: drawing, relation, formula, reversed formula and pattern. These words, although relating to representations of mathematical objects are not the common terms used. A formula and reversed formula were suggested in the form of algebraic expressions (;).

The task given in Ellice's 12th lesson was taken from Friedlander and Tabach (2001). This task included 4 situations each described by a different representation (story, table, graph and algebraic expression). The task included a set of sub-questions that guided the students to first relate to each of the representations alone and then connect between them.

The task given in the 12th lesson was more complex in two aspects: (1) the number of situations described, and (2) the number and type of representations provided. The task in the 2nd lesson included a drawing and tangible representations of one sequence only, whereas that in the 12th lesson included 4 situations described by 4 different representations (story, table, graph and algebraic expression). The students were asked to compare the phenomena. That is, there was a development in terms of the complexity of the given task. The tasks chosen by Ellice in both lessons included various sub-questions that helped students focus on specific representations and relations amongst them.

OVERVIEW OF TALLI'S LESSONS

The task provided in Talli's 2nd lesson included 5 different graphs and 5 verbal situations (e.g. *The amount of fuel in the tank changes according to the distance that the car rides.*) The students were asked to connect between them and support or refute claims by relating to data provided by the graphs.

The task given in Talli's 12th lesson was:

> In your summer job as a salesman, you could choose one of three earning methods: (1) 100 NIS for each working day and 35 NIS for each sale, (2) 80 NIS for each working day and 40 NIS for each sale, (3) 250 NIS for each working day and 5 NIS for each sale. Which would you choose? Explain your choice.

This task includes a verbal description of 3 situations that could be modeled by a function. The students were asked to compare between them. The task did not include reference to any representations. Also, it did not include sub-questions that could guide the students in their attempts to solve the task. This is in contrast with the task given in the 2nd lesson which included a graphic mediator and guiding questions. Also, the task given in lesson 12 asked for comparing alternatives whereas the task in the 2nd lesson asked for describing a situation provided by a graph.

METHOD OF ANALYSIS

To address the research question, we analyzed the entire whole-class discussion in each of the lessons. We focused on the instructors' talk in these discussions. We segmented the instructor's turns into clauses which were then analyzed. Thoroughly examining all the clauses uttered by the instructors, we noticed that they talked either about mathematical objects

(mathematizing – y changes according to x) or about the classroom participants (subjectifying – look at the board). However, we identified a third type of communication that is a sub-type of both mathematizing (because it speaks about math objects) and of subjectifying (because it speaks about persons). We call this last type – personifying, and define it as *non-alienated talk about mathematical objects*. Therefore, to analyze the data we categorized the clauses of the instructors' talk according to three categories: mathematize, subjectify and personify. Chi square test was used to determine whether differences are significant.

We further identify types of personification according to what we call *the distance* between the human actor and the mathematical object: one could act upon an object directly (e.g. *what can you say about the interception point?*), could describe her actions upon the object (e.g. *how do we know that the claim is true?*) or talk about how others would or should act upon the objects (e. g. *how do you think a 7th grade student would solve this problem?*). We name these categories as distance 0, 1 or 2.

FINDINGS

In this section we characterize instructors' talk to learn about how the instructor's choice of words promoted students' learning. We refer to three categories, (1) mathematizing, (2) subjectifying, and (3) personifying. Table 1 presents the number of clauses used by each instructor during the whole class discussions which were analyzed, and the (number) and percentages of clauses in each category. This table includes all the analyzed data that is discussed next. From Table 1 we see that both instructors used all three types of talk in each lesson. However, the distribution amongst the three types is significantly different (chi-square test, p<0.002).

Moreover, as can be seen from Table 2, in both of Ellice's lessons, the number of personifying clauses

	N	Math	Subject	Person
Ellice lesson 2	316	(53) 17%	(69) 22%	(194) 61%
Ellice lesson 12	157	(48) 31%	(37) 23%	(72) 46%
Talli lesson 2	219	(96) 44%	(28) 13%	(95) 43%
Talli lesson 12	220	(52) 24%	(8) 4%	(160) 73%

Table 1: Categorizing teachers' talk: mathematizing, subjectifying and personifying

(cls.) is significantly higher than that of mathematizing or subjectifying, while there is no significant difference between the number of mathematizing cls. or subjectifying cls. In Talli's 2nd lesson, subjectifying was significantly lower than personifying or mathematizing, while there was no significant difference between mathematizing and personifying. In Talli's 12th lesson, personifying was significantly higher than mathematizing and subjectifying, and mathematizing was significantly higher than subjectifying. In each of Talli's lessons there was significantly more talk about mathematics objects than about participants.

Next, we refer to changes between the two lessons for each instructor. Table 3 presents whether the changes in instructor's talk between her two lessons are significant (chi-square). We find that in Ellice's lessons, mathematizing is significantly higher in lesson 12 than in lesson 2 (p<0.001) and personifying is significantly lower (p<0.001). In Talli's lessons, subjectifying and mathematizing are significantly lower in lesson 12 than in lesson 2 (p<0.001). At the same time, personifying is significantly higher (p<0.001).

There is no clear tendency between the two instructors as for the differences in the three types of talk. This will be referred to in the discussion.

Inst.	Lesson	Personifying cls., Mathematizing cls., Chi-square value	Personifying cls. , Subjectifying cls., Chi-square value	Mathematizing cls., Subjectifying cls., Chi-square value
Ellice	2	194, 53, 80.8***	194, 69, 59.2***	53, 69, 2.1
	12	72, 48, 4.8*	72, 37, 11.1***	48, 37, 1.42
Talli	2	95, 96, 0.005	95, 28, 41.7***	96, 28, 41.7***
	12	160, 52, 55.0***	160, 8, 138.0***	52, 8, 32.3***

Chi square test with df=2. *p<0.05 **p<0.01 ***p<0.001

Table 2: Chi-square test for comparing the type of talk within each lesson

Inst.	Mathematizing cls.	Subjectifying cls.	Personifying cls.
	Les. 2, Les. 12, Chi-square value	Les. 2, Les. 12, Chi-square value	Les. 2, Les. 12, Chi-square value
Ellice	53, 48, 11.9***	69, 37, 0.181	194, 72, 10.3***
Talli	96, 52, 20.0***	28, 8, 12.2***	95, 160, 38.8***

Chi square test with df=1. *p<0.05 **p<0.01 ***p<0.001

Table 3: Chi-square test for comparing lesson 2 and lesson 12 for the same teacher

INSTRUCTORS' PERSONIFYING TALK

We identify three types of personifying talk according to the distance between the human actor and the mathematical object. Table 4 presents the number of personifying clauses uttered by each instructor during the whole class discussion and the (number) and percentages of clauses in each category. From Table 4 we see that both instructors used all three types of personifying talk in each lesson. However, the distribution amongst the three types is significantly different (chi-square test, p<0.001). Moreover, as can be seen from Table 5, in both of Ellice's lessons, distance-0 personifying is significantly higher than distance-1 or distance-2, while there is no significant difference between distance-1 and distance-2. In Talli's 2nd lesson, distance-2 personifying was significantly lower than the other distances. In Talli's 12th lesson, distance-0 personifying was significantly higher than distance-1.

Next, we refer to changes between the two lessons for each instructor. Table 6 presents whether the changes in the number of the instructor's personifying cls. between her two lessons are significant (chi-square). We find that in Ellice's lessons, distance 0 personifying is significantly higher in lesson 12 than in lesson 2 (p<0.001), while distances 1 and 2 are significantly lower (p<0.05). In Talli's lessons, the personifying talk remains unchanged related to the three distances.

DISCUSSION

This study is a part of a large-scale study in which teaching and learning processes were analyzed. Here we only refer to the teaching actions and specifically –

Inst.	Lesson	N	Distance-0	Distance-1	Distance-2
Ellice	2	194	(91) 47%	(56) 29%	(47) 24%
Ellice	12	72	(52) 72%	(12) 17%	(8) 11%
Talli	2	95	(55) 58%	(40) 42%	(1) 1%
Talli	12	160	(94) 59%	(64) 40%	(2) 1%

Table 4: Categorizing teachers' personifying cls. according to the distance between the human actor and the mathematical object

Inst.	Les.	Dist. 0, Dist. 1, Chi-square value	Dist. 0, Dist. 2, Chi-square value	Dist. 1, Dist. 2, Chi-square value
Ellice	2	91, 56, 8.33**	91, 47, 14.0***	56, 47, 0.876
Ellice	12	52, 12, 25.0***	52, 8, 32.3***	12, 8, 0.8
Talli	2	55, 40, 0.124	55, 1, 52.1***	40, 1, 37.1***
Talli	12	94, 64, 5.7*	94, 2, 88.2***	64, 2, 58.2***

Chi square test with df=2. *p<0.05 **p<0.01 ***p<0.001

Table 5: Chi-square test for comparing the type of personifying cls. within each lesson

Inst.	Distance 0	Distance 1	Distance 2
	Lesson 2, Lesson 12, Chi-square value	Lesson 2, Lesson 12, Chi-square value	Lesson 2, Lesson 12, Chi-square value
Ellice	91, 52, 13.5***	56, 12, 4.11*	47, 8, 5.51*
Talli	55, 94, 0.018	40, 64, 0.109	1, 2, 0.02

Chi square test with df=2 *p<0.05 **p<0.01 ***p<0.001

Table 6: Chi-square test for comparing lesson 2 and lesson 12 for the same instructor

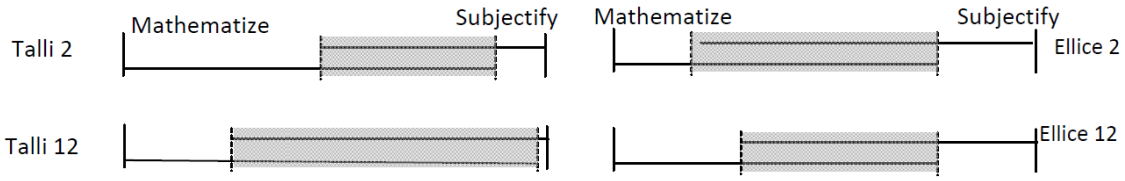

Figure 2: Distribution of mathematizing, personifying (in grey) and subjectifying talk

to teachers' talk due to space limitations. Findings from this study point to phenomena that suggest discursive mechanisms that could connect teaching and learning processes in general.

It seems reasonable to expect that during a lesson in mathematics an instructor would talk either about the participants (e.g., *open your books*, *work in groups*) or about the mathematical objects (e.g., *the function is positive for x<4*). However, from this study it is apparent that there is a third type of talk – about human participants acting upon mathematical objects (e.g., *when we move on the graph*), and that this talk is prevalent. Figure 2 presents personifying as the overlapping between mathematizing and subjectifying.

We did not find a similar pattern in the two courses regarding personifying. In Ellice's lessons, personification was used vastly in lesson 2 whereas in Talli's – in lesson 12. To make sense of this finding, we examined each of the lessons.

In Ellice's 2nd lesson there were several students' sayings that we could relate to Ellice's choice to personify. One is a student's publicly uttered saying of *I got lost*. Several other students joined this statement. Another, is the fact that while working on the task in small groups, at least 2 groups could not find the expression that mediated the given sequence, and therefore felt that they cannot solve the task. That is, the instructor faced a situation in which she had to make the mathematics accessible to her students. The way of doing it included personifying, in general and using distance-2 personifying, in particular. Personifying has the potential to make the mathematics more accessible to the learner as it includes talk about human who acts on mathematical objects. The distance-2 personifying includes others' actions on objects. This could protect the learner as it places someone else in the front, facing the mathematical objects. With that, it provides the learner with a role of judging someone else's actions on the mathematical objects. That is, it has the potential to both empower the student and protect her. Such expressions from the students were not uttered in Ellice's 12th lesson. This is coherent with our finding that Ellice's mathematizing was significantly higher in lesson 12, and her personifying was significantly lower. Likewise, distance-2 personifying was significantly lower in lesson 12.

In Talli's 12th lesson, in which personifying talk was significantly higher, we could not find explicit sayings of students' frustration. However, the students' initial responses to the task given in lesson 12 were local and surprised the instructor at this late stage of the course. Therefore, the instructor had to find a way to help students identify a reasonable strategy with which they could address the task. Thus, make the relevant mathematics accessible to them.

That is, we suggest that the personifying routine enacted by the instructor is strongly related to students' talk, and aims at enabling them to participate in the mathematics discourse by making this discourse more accessible to them.

Earlier, we stated that subjectifying is a communicational activity which motive is to produce narratives about people while mathematizing is a communicational activity which motive is to produce mathematical narratives. What, then, is the motive for personifying talk as a communicational activity? It seems that the motive is related to the activity of participation. That is, it seems that this is a communicational action whose motive is to produce mathematical narratives by first promoting students' participation and engagement in the mathematical discourse.

To substantiate conclusions from this work, larger-scale studies are needed, which will focus on relations between teaching and learning in general, seeking teaching-routines that promote learning. Also, they will focus on the specific discursive-routine of personifying aiming to define the when and the how of this routine.

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