Self-Video-Based Discourse as a Lever for Developing Pre-Service Mathematical Knowledge for Teaching

Ruti Segal[1], Yaron Lehavi[2], Avi Merzel[3], Ami Baram[4], Bat-Sheva Eylon[5]

Weizmann Institute of Science and Shaanan Academic College of Education, Israel[1]
Weizmann Institute of Science and The David Yellin Academic College of Education, Israel[2]
Hebrew University of Jerusalem, Israel[3]
Shaanan Academic College of Education[4,5]

Abstract

Over the last decades, videotaping has been widely accepted to be a useful tool for teachers' professional development-(PD)([1];[2]). Compared with analyzing other teachers' videos, teachers who analyzed their own teaching experienced higher activation, manifested by higher immersion, resonance, and motivation. In addition, they became more aware of relevant components of teaching and learning ([3]). In this study, we adopted Mason's framework (1998) ([4]),for such levels, developed for mathematics teachers. This led us to develop a program The Video-Based Didactic discourse-(VBD discourse) whose aim is to provide mathematics and physics teachers with professional development. The mathematics education researchers' community has become interested in characterizing the required knowledge for mathematics teaching. Relying on Shulman's (1986) work, [5] defined the term "Mathematical Knowledge for Teaching"-(MKT) as knowledge that crosses areas and levels of school mathematics, supports connected ideas, and emphasizes the ability to plan, integrate and manage appropriate mathematical content for teaching. Following this work, [6], presented six different components of MKT. Two of them are particularly relevant to this study: Specialized Content Knowledge-(SCK) and Knowledge of Content and Students-(KCS). The purpose of our research was to examine how the VBD discourse contributes to the development of five pre-service teachers' MKT, during their participation in a Didactics of mathematics course at the Academic College of Education. An analysis of the findings indicates that the VBD discourse based on their video mathematics teaching raised their awareness, and contributed to the development of their SCK and KCS.

Keywords: *Discourse, Professional development, Mathematics education.*

Theoretical background

Video as a tool for teachers' professional development

Videotaping has been widely accepted to be a useful tool for teachers' PD. The choices what to focus on, and what methods to use has changed over the years ([1];[2]). Developing the ability to reflect on classroom events is one of the main goals of teacher training process, which is thought to be fostered by video-based observation ([7]). Teachers are commonly encouraged to observe either their own teaching videos or those of others ([8]). Compared with analyzing other teachers' videos, teachers who analyzed their own teaching experienced higher activation, manifested by higher resonance, and motivation [7]. Moreover, use of video encouraged changes in their teaching habits because it helped teachers to focus on their analysis, view their teaching from a new perspective, trust the feedback they received, feel free to change their practice, and see their progress ([9]).

Mathematics teachers' knowledge

Over the past few decades, the mathematics education research community has become interested in characterizing the required knowledge for mathematics teaching. Shulman (1986) recognized that the required teacher's knowledge is unique and suggested two main types of knowledge teachers required, not necessarily in mathematics: Subject Matter Knowledge and Pedagogical Content Knowledge. Relying on Shulman's work, ([5]) attempted to distill the knowledge required from mathematics teachers. They defined the term Mathematical knowledge for teaching as knowledge that crosses areas and levels of school mathematics, knowledge that supports connected ideas of the mathematics teacher, and emphasizes the ability to plan, evaluate, integrate and manage appropriate mathematical content for teaching. Following this work, ([6]), presented six different components of mathematical knowledge for teaching. One of these components related to subject matter knowledge: **Specialized Content Knowledge** (SCK). This component includes the mathematical knowledge and

skills unique to teaching that not typically needed for purposes other than teaching, such as searching for student errors. Another component related to pedagogical content knowledge: **Knowledge of Content and Students** (KCS). This component includes knowing how students think, what may confuse them, or difficult for them, and more.

Theoretical framework

Teachers' professional growth involves climbing from lower to higher levels of awareness with regard to teaching. Here we adopted a part of [4] framework for such levels, developed for mathematics teachers: **Awareness in action**: Awareness of the ability to choose, distinguish, and more. **Awareness in discipline** (knowledge of awareness in action): Awareness of the ability to examine how the teacher performs the actions mentioned at the previous level, while addressing discipline.

The VBD discourse approach: principles and practice

The widely agreed potential of using video analysis in teachers' PD led us to develop a program whose aim is to provide math (and physics) teachers with professional development by using video analysis effectively. The program utilizes an approach that emphasizes a specially designed Video-Based Didactic discourse (VBD discourse).

Here we will describe one case study that aimed at revealing how using our VBD program as part of the teaching a Didactics course of pre-service mathematics teachers at the College of Education, changed teachers' focus of attention and his levels of awareness.

Our VBD discourse based on some principles [10], such: Use of evidence, Ownership, Autonomy, Introspection, and an inquiry focus.

The steps of the VBD in this study are as follows: (a) the pre-service teacher videotapes his or own lesson, chooses a short episode from that lesson (5-7 minutes), and provides it with a title. (b) The lecturer in the course is one of the research team members (the trainer) prepares the didactic discourse, based on this video segment, by watching it with a critical, non-judgmental eye. (c) The trainer and the pre-service teachers then meet (face to face or online) and discuss. The meeting recorded.

Research method

The research method focuses on case studies.

Research Question

What support provided by the VBD discourse to the development of pre-service math teachers' MKT?

Research Instruments

Recording of: (1) Short video segments from the pre-service mathematics teachers' lessons in classroom. (2) A VBD discourse with the pre-service mathematics teachers guided by one member of the project team. (3) Interviews with the pre-service mathematics teachers after the VBD sessions.

Findings

We will present here partial findings based on the above-mentioned resources.

The following is a short description of the part of an episode chosen by Uri (pseudonym) and part of the VBD discourse that took place based on that episode.

Episode 1: Movements of the quadratic function

Uri taught ninth graders students the connection of algebraic and graphic representation of the quadratic function. Starting with the function $y = x^2$, and thus the vertical movement of the function $y=x^2+k$. Uri held a discussion with his students, leading them to understand that when k represents positive values, the function $y = x^2$ moves k units upward, and where k represents negative values, the function $y = x^2$ moves k units downward. Then Uri asked the students "How the graph of the function $y=(x-p)^2$ will look?. Student 1 said: ""The function $y=(x-p)^2$ is always positive". Uri did not respond to student 1 and added: first we saw that the parameter k in the algebraic expression $y=x^2+k$ influancing the parabola graph movement up or down. So, what can be said about the parameter p in the function $y=(x-p)^2$?. Student 2 said: "May be the function moves along the x-axis". Uri praised students' 2 answer.

Part of the VBD discourse between Uri and one of the program's staff (following episode 1):

The first part of the discussion with Uri focused on the fruitful discussion he had with his students. Uri explained that his goal in the current lesson was to establish the students' understanding of the

relationship between the algebraic expression and the quadratic function graph. The following dialogue ensued:

Trainer: I noticed that when you asked about the function $y=(x-p)^2$, student 1 answered that "the function always receives positive values. Did you hear that?

Uri: No, I did not.

Trainer: What do you think about his answer?

Uri: Well, this is not the direction; I intend to lead the discussion.

Trainer: What was the direction you intend to lead the discussion?

Uri: I wanted to lead the discussion so that the students would understand the relationship between the algebraic expression function $y=(x-p)^2$ and the graph. I wanted to lead them to understand that the values of the parameter p moves the parabola graph to the right or left.

Trainer: Do you think student 2 understood the relation between the values of the parameter p and the movement of the parabola graph?

Uri: I do not know.

Trainer: How can you recognize that the student did understand?

Uri: Just as they realized that the parameter k affects the vertical shift, they understand that the parameter p affects the horizontal shift.

Trainer: Do you think that for students the understanding the vertical displacement is the same as understanding horizontal displacement?

Uri: ….I do not know…. I never thought about it .... I thought that the process of understanding vertical displacement is the same as the process of understanding horizontal displacement

The VBD discourse led Uri to a turning point [11], as expressed in the VBD discourse. This turning point aroused Uri's awareness as a mathematics teacher on two levels [4]:

Awareness in action: Awareness of the presenting the connection between the parabola algebraic expression and the graph, awareness to students answers, awareness of students' understanding the connection between algebraic expression and graphical presentation.

Awareness in discipline: Awareness of the importance of using students answers to promote effective discussion, awareness of the important of using technology through teaching, awareness of different ways to explain the role of the parameter in the algebraic expression of the parabola.

Conclusion

In the present study, we presented some evidence for the professional development of one pre-service mathematics teacher during an effective VBD discourse. The findings of this study indicate that VBD discourse is a significant tool that contribute to the professional development of pre-service mathematics teachers, as well as, to the development of their SCK and KCS.

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