Mediating role of technology: prospective upper secondary mathematics teachers' practice

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Effective use of technological tools leads us to the mediating role of technology. This role is not only concerned with how to use technology in the classroom but also with how technological tools make the interaction between teacher and students possible. This study examines how prospective mathematics teachers provide a mediating role for technology in the classroom and use technology with the purpose of achieving teacher-student interactions. For this aim, a case study was conducted. Data collection tools were semi-structured interviews, lesson observations and lesson plans each of which includes a teaching activity using dynamic software such as Geometer's Sketchpad and Geogebra. The analysis of data indicated that prospective teachers used technological tools with the aim of visualisation of mathematical concepts and emphasising relationships. They had difficulties with negotiating the meaning of mathematical concepts and establishing mediation between students, themselves and technological tools.

Keywords: prospective mathematics teachers; instructional technology; mathematics teacher education; mediation; interaction in the classroom

Introduction

Digital technology can provide tools that are dynamic, graphical and interactive and help students explore mathematical objects and make them more tangible and manipulable (Hoyles & Noss, 2009). Research on the effectiveness of technological tools in learning mathematics revealed that using tools help students not only develop their mathematical performance and proving skills but also promote learning (Choi-koh, 1999; Gurevich, Gorev & Barabash, 2005; Pitta-Pantazi & Christou, 2009).

Despite the great emphasis on using technological tools in mathematics education research, it is difficult to say that a real integration of technology in school practice has been achieved (Mariotti, 2006). With this regard, Drijvers (2012) defines three key factors which promote or hinder the successful integration of digital technology in mathematics education (as cited by Freiman, 2014). These are the role of the teacher, educational context, and design. In this context, one of the most critical questions is how technological tools are better used for strengthening students' mathematical learning in the classroom. This question brings us to the concept of 'mediation' presenting a Vygotskian perspective for interpreting the functioning of new technical tools within the theoretical framework of social construction of mathematical knowledge.

The concept of mediation

Vygotsky (1978) points out the importance of social and cultural contexts which influence learning. This suggests "a strong relationship between the individuals and the social world around them according to which the meanings are shaped under the mediation of the culture in the form of tools and in particular of language" (Biza, 2011, p.129). These tools could be psychological or physical tools, or signs such as words, graphs, mathematical symbols.

Mediation is a very common term in educational literature. It is used for referring to the potentiality of fostering the relation between pupils and mathematical knowledge, and mostly related to the accomplishment of a task. This notion also helps us to analyse interactions between the user and the environment (Lagrange, 1999). Moreover, teachers' appropriate use of tools can mediate a mathematical discussion and help students to construct mathematical meanings instead of strictly personal meanings (Mariotti, 2001).

The term of mediation is derived from the verb 'mediate'. As can be seen in Figure 1, this term has four components: 'mediated', 'mediator', 'mediate'" and 'modality/site'. In the classroom setting, these components reach significance for the mediation approach.

Abramovich and Connell (2013, p.3) explain the major claim of this approach as follows:

> the mediational means shape human action in many essential ways. Thus, the term mediated action reacts the fundamental relationship between the action and mediational means which it employs. Any mental action directed towards solving a mathematical problem and mediated by appropriate tools and signs may be termed as mediated mathematical action.

Similarly, technological tools have a mediator role among the components of mediation. Mediator function of the computer is related to the possibility of creating a communication channel between the teacher and the pupil based on a shared language (Mariotti, 2001; Noss & Hoyles, 1996).

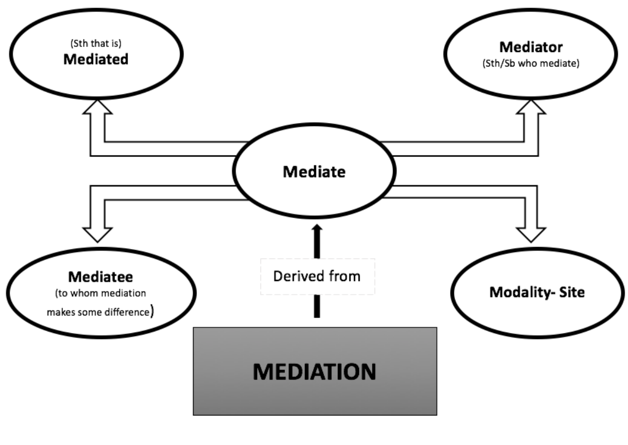

Figure 1: The components of 'mediation'

This study examines how prospective mathematics teachers provide a mediating role for technology in the classroom and use technology with the purpose of achieving teacher-student interactions. We are particularly interested in whether prospective teachers use a technological tool as a purpose on its own or as a tool for constructing mathematical meanings.

Methodology

This qualitative study was designed as a case study which was conducted during the 2013-14 academic year of a teacher preparation program in a mathematics education department in a state university in Istanbul, Turkey. It was a four-month program which accepts graduates who have a BSc degree in mathematics. Participants are two female prospective mathematics teachers. The data were collected during two courses: 'Instructional technologies and material development' and "Teaching practice' which were conducted by researchers during the study. During 'Instructional technologies and material Development' course, participants were involved in hands-on activities in front of a computer and prepared teaching materials using Geogebra and Geometer's Sketchpad. Participants also taught lessons in partnership schools during the 'Teaching practice' course.

The data collection instruments are observations, lesson plans and semi-structured interviews. Each participant taught a total of five lessons in a partnership school. At least two of these lessons were technology-based. They were interviewed after their lessons. During the semi-structured interviews, they were asked how they used technology in their lessons and which role they attributed to technology in their lessons.

Interviews and lesson videos were verbatim transcribed. Considering the aim of this study, the transcripts were analysed using descriptive analysis method in terms of purposive role or tool role attributed to technological tools to reveal the ways in which pre-service teachers gave a mediating role to technological artefacts. Lesson plans were used for triangulation purpose.

Findings

This section reports findings from observation and interview data. We exemplify roles attributed to technological tools by presenting teaching episodes from Melek's lesson on trigonometric functions and Oya's lesson on constant functions.

Melek used Geometer's Sketchpad to explain how to draw trigonometric functions. She first drew the graph of y=sinx and then asked one of her students to draw y=cosx. She then, together with the class, drew the y=cosx using the software as can be seen in Figure 2. Later she discussed with her students how to draw y=tanx using the software (see Figure 3) and tried to reach a common ground which is tanx=sinx/cosx. Below excerpt is from her lesson which she taught during her school placement:

> Melek: Does anyone like to draw the graph of tanx?
>
> Students: This time we will construct a unique point with x and y?
>
> Melek: Should we construct a unique point with x and y?
>
> Student: No, intersection point
>
> Student: We will take the division
>
> Melek: Division of what?
>
> Student: y/x
>
> Melek: Is it y/x?
>
> Student: No, isn't it x/y?

The discussion continued until one of the students gave the correct answer and Melek asked him to came to board and showed it to the whole class.

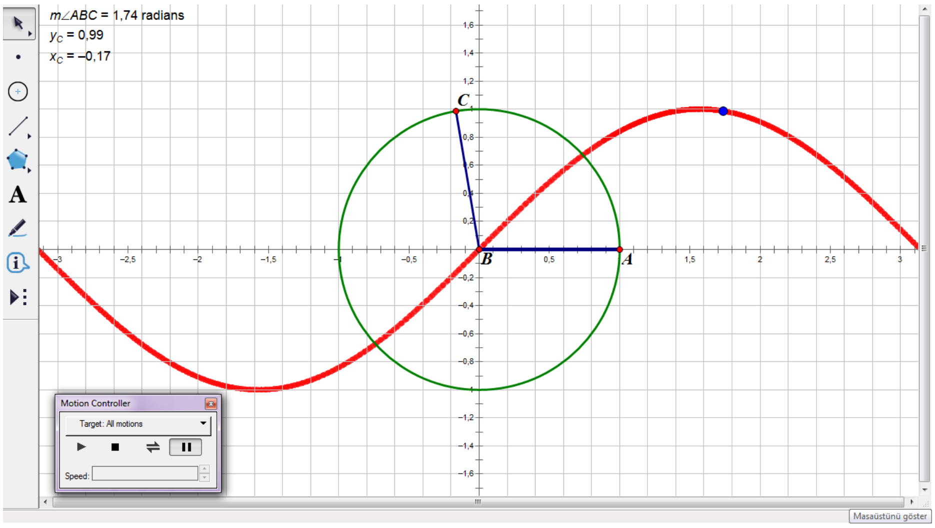

Figure 2: Melek's drawing of y=sin*x* using Geometer's Sketchpad

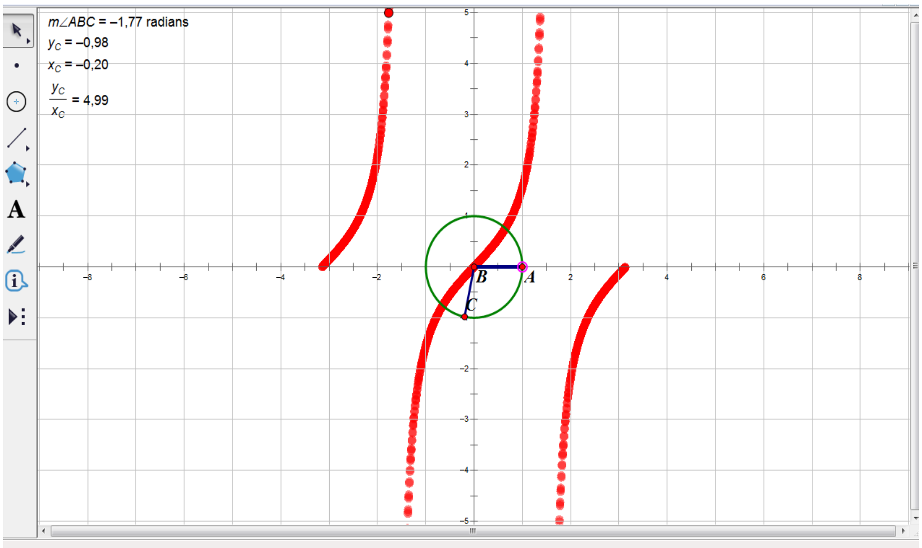

Figure 3: Melek's drawing of y=tanx using Geometer's Sketchpad

As can be inferred from observational data, Melek used the technological tools merely for visualisation. Interactive features of the software (slide, tracing, etc.) provided a teaching aid rather than a communication channel between student thinking and the mathematical concept.

The other prospective teacher Oya prepared a task using GeoGebra for the concept of constant function. The excerpt below is an episode from her lesson which she taught in a partnership school:

> Now, we will make two slides to define constant function: One of these slides is called "a" and the other is called "b". For the slide "a", we will specify the interval from -1 to +1. At this stage, it must be emphasised that students can choose any interval for the slides. The second slide will be for the independent variable of the function. Students will be asked to move the slides and asked what they observe. Here, we will observe however they change the value of "b" by means of slide, the graph of function will not change.

As can be seen in excerpt above, Oya's task using Geogebra put an emphasis on variation by making use of slide "b" which represents the independent variable. At this point, it should be mentioned that research points out students' poor concept images of constant functions (Akkoc & Tall, 2002). Students might find it difficult to accept a constant function as a function. One of the reason of this is the way examples of constant functions are given as "$y = a$". This expression does not contain a variation.

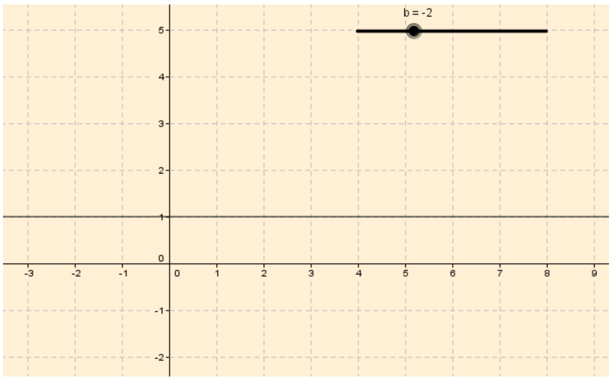

Figure 4: Oya's task on constant function using Geogebra

As can be seen in Figure 4 above, as the slide b is moved, the graph does not change. Therefore, the task mediated by GeoGebra may provide a new channel for students by including a variable in constant function ($f(x)$ = a) by varying the independent variable using a slide.

Discussion and Conclusion

The aim of this study was to analyse how prospective mathematics teachers provide a mediating role for technology in the classroom and use technology with the purpose of achieving teacher-student interactions. For this aim, two prospective mathematics teachers' technology integration processes were examined in terms of purposive role or tool role.

As can be seen in the first example, the prospective teacher Melek used the Geometer's Sketchpad as a tool for presentation rather than a tool for mediation. However, for a successful integration of technology in a mathematics lesson, technological tools should promote student thinking as a result of interaction between students' actions and technological tools' interactive feedback. Therefore, roles attributed to technological tools are important aspects of the interaction between student and computer interaction (Heid, 1997). The concept of mediation requires not only creating a new communication channel including shared signs but also filling a gap where mathematical concepts could not be constructed by teachers and students. With this regard, it can be claimed that Melek did not attribute a tool role to the software she used.

On the other hand, the second prospective teacher Oya used Geogebra as an effective tool. Bussi and Mariotti (2008) put forth that technological tools have great potential in order to assume the role of mediator because of a natural connection between tools and mathematical concepts. With this regard, it can be claimed that the prospective teacher Oya made use of this potential. She aimed at overcoming students' difficulties with constant function by using the slide feature of the technological tool. She designed the learning environment so that students could interact with the software.

The findings of the study imply the importance of training prospective mathematics teachers for using technology as a tool for mediation. Mathematics teacher educators should pay special attention in developing the required knowledge and skills for successful technology integration with regard to mediation.

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