Kept Cheek by Jowl: Technology and Math-Teachers, and Student-Teachers' Community of Practice (Short Paper)

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יד ביד: טכנולוגיה וקהיליית מעשה של מורים למתמטיקה ופרחי הוראה (מאמר קצר)

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Abstract

The growing number of technology-mediated professional communities creates learning opportunities that remain to be explored both theoretically and empirically. This paper draws on a study that looks into the affordances embedded in a mathematics education community of practice (Wenger, 1998) comprised of two mathematics teachers in the Israeli Virtual High School (VHS) and a class of 25 student teachers at the Technion. The purpose of this paper is to describe three areas of development that was experienced by both the VHS mathematics teachers and the Technion student teachers. Specifically, the study focuses on how the teachers and the student teachers' collaboration generated opportunities for all participants to develop their respective knowledge of technology, pedagogy, and content (TPACK) in the context of high school mathematics.

Keywords: Technology, Pedagogy, Content Knowledge, Mathematics Education, Community of Practice.

To ensure an effective and efficient use of current, and of yet-to-be developed, technological tools in the teaching and learning of mathematics, the Association of Mathematics Teacher Educators (AMTE), 2006) has assigned universities the responsibility for preparing pre-service teachers of mathematics. It has thus called teacher educators to generate opportunities for pre-service teachers to: explore and learn mathematics using technology in ways that build confidence and understanding of the technology and of mathematics; model appropriate uses of a variety of established and new applications of technology as tools to develop a deep understanding of mathematics in varied contexts; make informed decisions about appropriate and effective uses of

technology in the teaching and learning of mathematics; and develop and practice teaching of lessons that take advantage of the ability of technology to enrich and enhance the learning of mathematics (AMTE, 2009, p. 2).

That this mission is not as straightforward as it may seem was empirically established by Niess (2005) who identified the problem in, inter alia, the design of many teacher-education programs that—more often than not—teach the mathematical content and pedagogical content knowledge separately from technology. This disconnect between the use of technology on the one hand and the learning of content and pedagogical content knowledge on the other hand needs to be bridged to be able to answer questions that include but are not limited to: "What technologies are adequate tools for learning mathematics? What about teacher attitudes and beliefs about teaching mathematics with technology?" (Niess, 2006, p. 195). To address this need of bridging between the use of technology and the teaching of content, Biton et al. (2017, 2018) harnessed the work done in the VHS for the purpose of creating a mathematics-related TPACK (Mishra & Koehler, 2006) framework. To extend this work, two mathematics teachers from the VHS sent two of their recorded lessons in advanced-level mathematics to pre-service teachers in the Technion for them to watch and come up with queries related to what they saw in the recorded lessons.

Technology for TPACK-enhanced Learning

Following the viewing of recorded lessons from the VHS, the Technion pre-service mathematics teachers were asked to individually select two episodes from the videos and formulate queries in relation to what they saw. The queries were then collected by the course instructor (first author) and emailed to the VHS teachers for their consideration. The teachers were then invited to participate in a synchronous discussion with the Technion students over the queries that were sent to them. This was followed by a questionnaire that was disseminated to the students to elicit their perception of the experience.

In a close examination of the type of questions asked, the knowledge shared, and the discussion that evolved, the authors have not only identified a strong cohesion between learning about mathematics-related technology, pedagogy, and content knowledge but also a change in attitude among the pre-service teachers toward the use of technology in teaching mathematics. The following sections shed light on the different types of learning that evolved in and through the interactions.

Technology and Dynamic Tools

The VHS mathematics teachers demonstrated the use of Geogebra in many topics that were raised by the pre-service teachers. For example, the idea of the Ferris Wheel, was used to demonstrate the graphs of trigonometry functions such as the sinus function. Overall, the VHS teachers demonstrated their continuous effort in integrating technological tools in their teaching.

Pedagogical Content Knowledge

One episode was about a Grade-12 student asking questions in relation to a mathematics concept. The teacher tried to answer the questions but these did not satisfy the student who persisted and asked more questions. The teacher then moved on to answer a question another student had. One of the pre-service teacher asked: How can you ensure that students understand the material and that there are no misconceptions or misperceptions? The discussion that evolved was a learning

experience not only for the pre-service teachers but for the VHS teacher as well as they shared ideas to answer this and other related questions.

Content Knowledge

In an episode that focused on applying and graphing an inverse function for an original function, the teacher used digital tools to show how an increasing interval turns into a decreasing interval and vice versa; the x values become vertical asymptotes; a horizontal asymptote y=c turns into y=1/c. A maximum value turns a minimum value and vice versa with an emphasis on a recalculation of the end point. One pre-service teacher asked: I am missing the reference to the point of discontinuity!!!! She then asked:

> 1) Under what condition during work on an inverse function does (a) a point of discontinuity remain a hole, (b) a point of discontinuity turn into an asymptote; 2) What is the inverse function of the function in the given problem?; and 3) what is the graph of the derivative?

Again, the ensuing interaction generated a enthusiastic conversation among the pre-service teachers and the VHS teachers.

That this has taken the form of an opportunity for both the participating VHS teachers and the pre-service teachers to refine their thinking about TPACK and to witness, first hand, how technology, content knowledge, and pedagogy are intertwined not only reifies the visions of a future where many more mathematics classes use TPACK as a framework to maximize learning but also invites further deliberations over Niess's (2006) urge to identify "actions that must occur to move toward these visions" (Niess, 2006, p. 196).

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