MATHVISION: A MOBILE VIDEO APPLICATION FOR MATH TEACHER NOTICING OF LEARNING PROGRESSIONS

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We report on the development and evaluation of MathVision, a mobile-application designed to develop Virtual Professional Learning Communities through asynchronous discussion about 2nd, 3rd, 4th, and 5th grade students' mathematical thinking. MathVision allows teachers to upload videos of problems solving sessions using Cognition Based Assessment tasks and foster discussion aligning those strategies to research-based learning progressions for Length and Measurement. Our findings indicate that while it was possible to develop such an interface, sparking productive online discussion was difficult. The application served as a tool for enhancing physical teacher meetings and drawing attention to student thinking consistent with conducting task-based interviews, rather than actually facilitating this talk entirely.

Keywords: Learning Progressions, Technology, Elementary School Education, Geometry and Geometrical and Spatial Thinking

MathVision is a mobile application learning technology designed to help 2nd, 3rd, 4th, and 5th-grade elementary teachers develop a virtual professional mathematics community in their schools around noticing student's mathematical thinking. Specifically, teachers use MathVision as an all-inclusive tool to capture short video of their students solving validated mathematical tasks and then engage in chat room-like asynchronous, online discussions about what they notice in these videos. We built MathVision upon the extensive research on mathematics teacher noticing (Jacobs, Lamb, & Philipp, 2010; Sherin, Jacobs, & Philipp, 2010), teacher video clubs (Van Es & Sherin, 2008, 2010), learning progressions (Battista, 2011, 2012), and professional learning communities (DuFour, 2004).

In building and piloting MathVision in an elementary school, we explored the following research questions: 1) How should a Virtual Professional Learning Community (VPLC) environment be created that enables elementary mathematics teachers to base their teaching on research-based mathematical Learning Progressions, without requiring timely and resource-heavy physical interactions between teachers thus making teacher learning more accessible? 2) What affordances of MathVision will teachers utilize (i.e. commenting on each other's videos, noting each other's learning progressions ratings, a database of mathematical tasks) within their classroom practice? 3) How might using these features affect their teaching practice? 4) How will physical team-meetings be altered or augmented through the use of this technology, which allows teachers to view each other's videos before these meetings? And 5) How will teachers interact and talk to each other in reference to the technology?

Background and Rationale

Mathematics Teacher Noticing

Emphasizing how a teacher specifically listens to and responds to what a student says or does is one of the core tenants of modern mathematics education reform, often referred to a "professional noticing" (Jacobs et al., 2010). The very act of listening itself opens up space for a student to share his or her mathematical strategy, thereby positively impacting a student's mathematical growth (Empson & Jacobs, 2008). However, learning how to listen to and respond to student's mathematical thinking is a complex process that takes years to develop (Jacobs et al., 2010). There has been some evidence that video clubs, in which teachers watch video of each other's classroom teaching, can help teachers in the same school develop these crucial noticing skills (Van Es & Sherin, 2010). However, video clubs require busy teachers to find a common space and time to meet. Yet, when teachers watch and analyze student's mathematical thinking on their personal devices (e.g. smartphones, tablets), they can more better focus on the nuances of a student's thinking in much more detailed ways than video clubs (Author).

Virtual Professional Learning Communities

One research-based solution for supporting teacher learning without requiring high demands of support and time involves using Professional Learning Communities (PLC), which revolve around learning, collaboration, and instructional action (DuFour, 2004). Teachers working within PLC structures often have better instructional approaches, are more satisfied with their careers, and are more likely to remain in teaching long enough to become accomplished educators (Fulton & Britton, 2011). Yet because of a lack of shared spaces, meeting times, and the small number of teachers with common mathematics grade-levels in the same building, elementary school culture in the U.S. often prevents effective PLC organization. To solve this problem, we developed a learning technology environment that fosters the creation of a Virtual Professional Learning Community (VPLC) that can go beyond school boundaries so that elementary mathematics teachers can connect with each other without having to find a common meeting time and space (McConnell, Parker, Eberhardt, Koehler, & Lundeberg, 2012).

Research-Based Learning Progressions to Understand Students' Mathematical Thinking

Often missing from most mathematics teacher support models is assessment practices utilizing research-based Learning Progressions (LP), which help teachers understand the complexities involved in students' evolving mathematical thinking. The Cognition Based Assessment series provides research-based assessment tasks for teachers to identify students' Learning Progressions and then follow-up with relevant instructional tasks. However, the successful implementation of CBA-based mathematics instruction requires teachers to regularly meet to watch video from each other's classroom and discuss how they would interpret individual student's thinking on the learning progressions. As stated earlier, however, modern elementary school culture in the U.S. makes it difficult for regular teacher meetings to come together to focus on mathematical thinking or pedagogy (Horn, Garner, Kane, & Brasel, 2017).

Building upon these various literatures on mathematics teaching, we built a mobile application, MathVision, to see what would happen if teachers could capture and upload videos of students working on CBA tasks and then use the same application to discuss these students' strategies and how those strategies aligned to the established learning progressions. Key to this research was building technology that met teachers where they are: the technology had to work on multiple devices (e.g., laptops, phones, tablets), had to be intuitive to use for capturing and commenting on video, and had to contain all necessary supports and materials (i.e., the CBA tasks, the learning progressions framework, etc.).

Methods

Research Design and Measurement/Instruments

Since the main purpose of this study involved building and piloting a new learning technology, the research design followed a case study methodology of teachers using the actual technology, videos and discussion captured from within the MathVision application, observations from teacher team meetings after they had used MathVision in their teaching, and interviews with teachers. Teachers used MathVision as a grade-based team, meaning that all the 4th-grade teachers viewed and

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commented on each other's videos.

During this 4-week intervention, teachers regularly used this learning technology to assign CBA research-based mathematics tasks about Length and Measurement to their students (Battista, 2012). Teachers then selectively captured video of their students' strategies as they solved these tasks, focusing on particular on strategies that might elicit conversation among their professional learning teams. Within each team, teachers uploaded, commented and categorize on each other's videos according to the CBA-framework and selected where on the Learning Progression scale they feel the student was in their mathematical thinking (Figure 1 & Figure 2). Teachers then engaged in chatting with each other about the specific videos through these online discussions. In particular we were interested in how teachers came to consensus with respect to student comments on particular corresponding CBA levels and the means by which they recommend instructional support to scaffold students through their thinking.

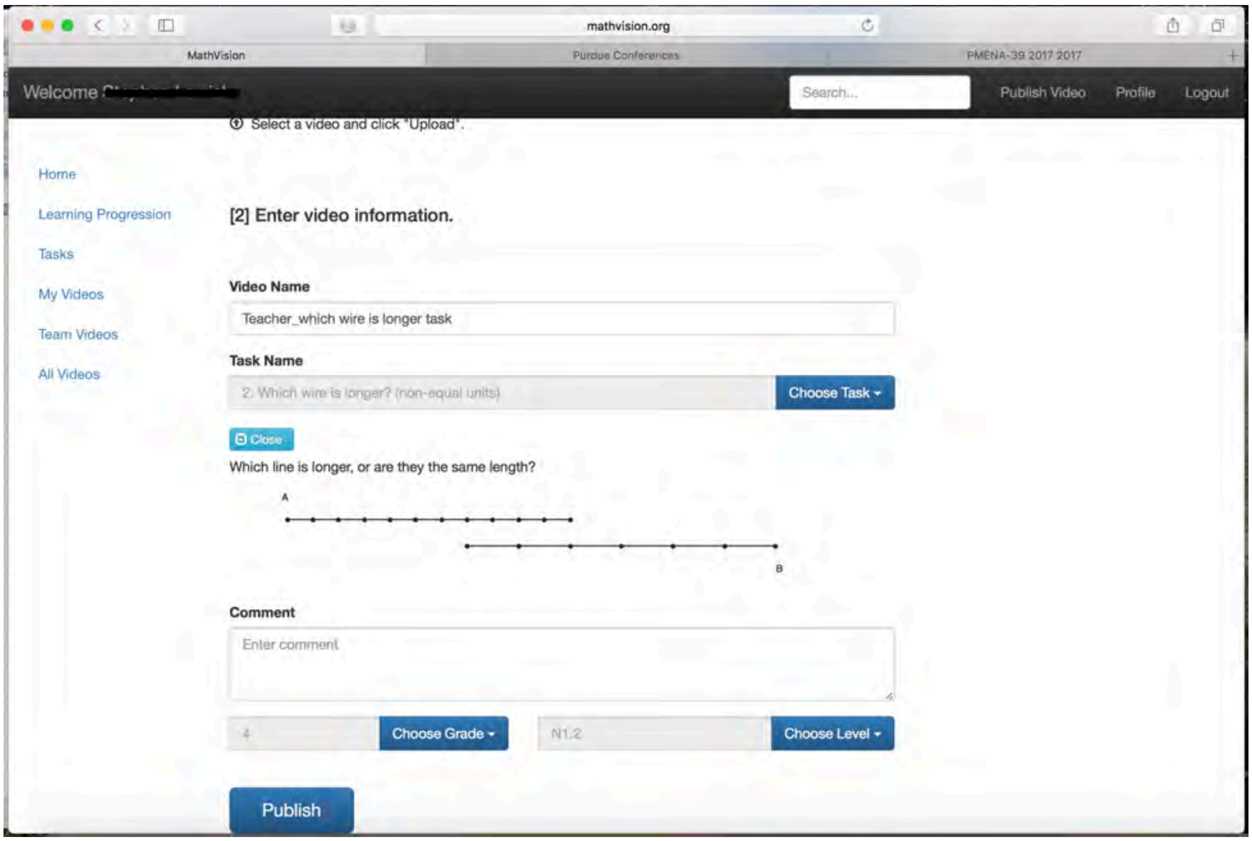

Figure 1. Video upload page where teachers enter metadata for video files including grade level, initial alignment to CBA level, corresponding task and initial thoughts or comments on problem solving strategies.

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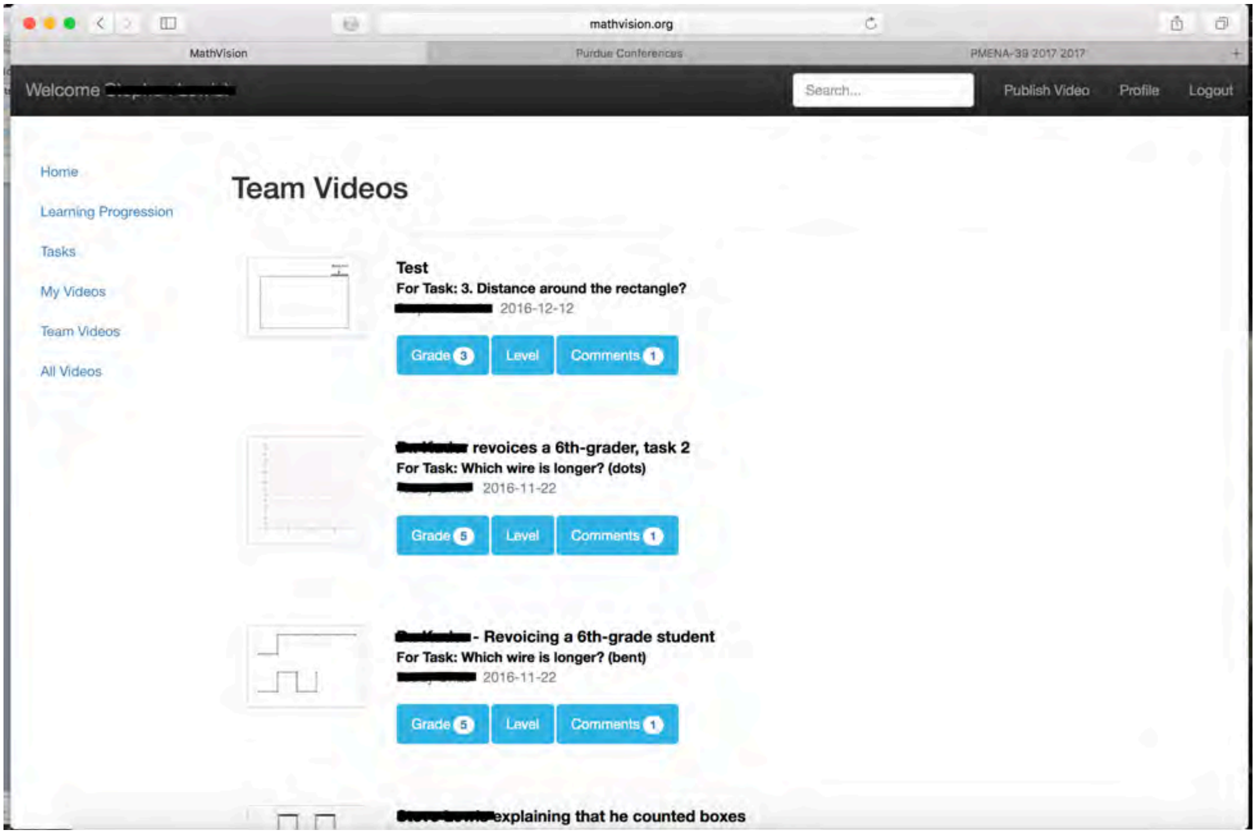

Figure 2. Repository of team videos designating grade, Learning Progression level, and comments where teachers can organize videos by team, individual videos or all videos.

Classroom Observation and Teacher Generated Video

During this 4-week intervention, our first point of data involved visiting the partnering classrooms to observe and capture video of how teachers and students used and interacted with the technology. This involved a research team member capturing video of the mathematics classroom, following the teacher as he or she used the MathVision technology with students.

Additionally, while the teachers used MathVision, they continually generated video and text data through uploading videos of their students and commenting on their own and other teachers' videos (Figure 3). Our second point of data involved our research team monitored this data collection as it unfolded, noting the progression of the teacher discussion and sophistication of the students' mathematical strategies.

Finally, at the end of the 4-week intervention, our research team met up with all the teachers, the mathematics instructional team, and the administrators who used MathVision for a reflective debrief. For our third point of data, our research team conducted follow-up focus group interviews with the teachers, instructional leaders, and administrators about their experience with the technology and how they used it. The focus of these interviews was to learn how the MathVision application helped in their professional practice, what particular changes or features might be beneficial to add, and how MathVision might fit into their school culture.

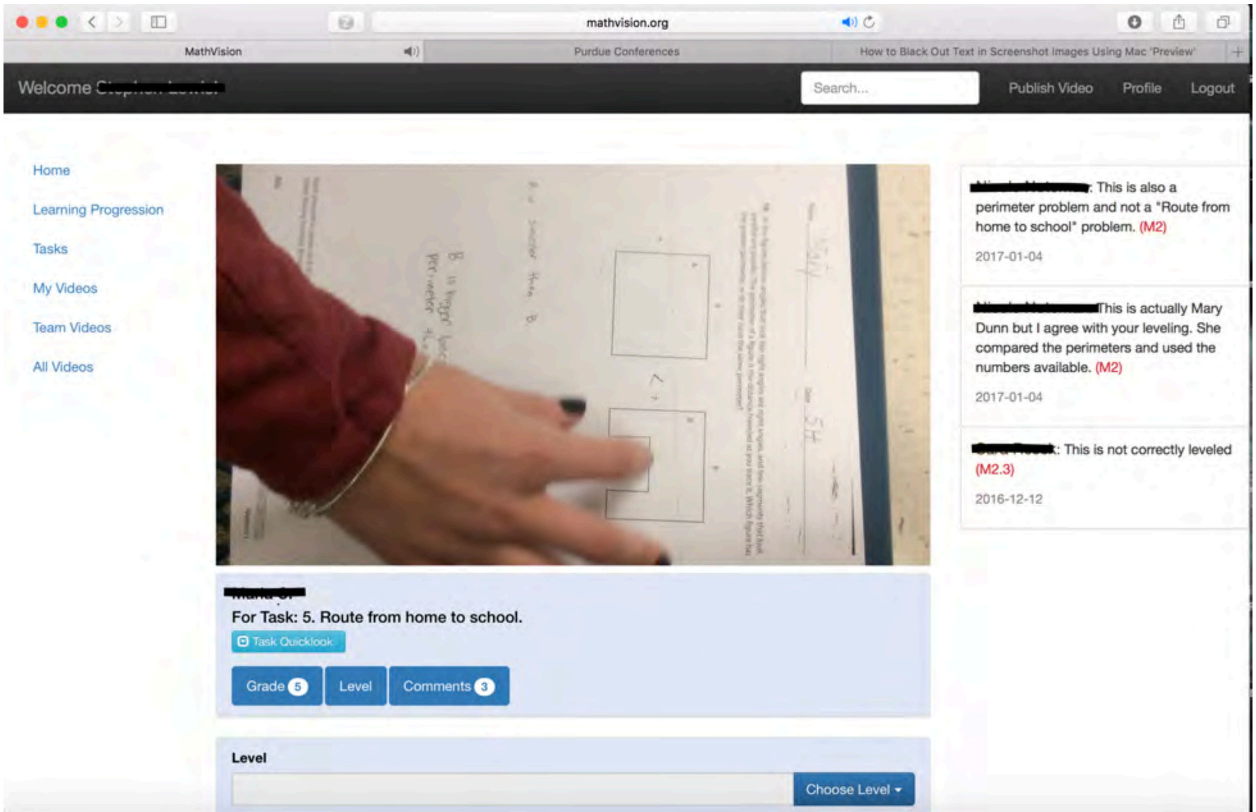

Figure 3. Video watching and commenting page allowing teachers to look at student strategies and engage in asynchronous chatting with other team members on aligning those strategies to CBA levels. Each comment (on the right) is tagged with a CBA level as a means for calling attention to particular aspects of the learning progression.

Sample

The Sample for this study consisted of the 2nd, 3rd, 4th, and 5th-grade teacher teams, the mathematics instructional team, and the administrators of a public elementary school in a high-socioeconomic neighborhood in a mid-sized city in Midwestern United States. Each math team consisted of 3 teachers and their 20 to 25 students. The mathematics instructional team consisted of the schools permanent mathematics instructional coach who also taught enrichment mathematics classes, and the administration group consisted of the head principal and the instructional leader for the school.

Internal Validity

While this research study utilized a case study methodology based around observation of participants using the technology, we also focused on the building and usability of the technology along with observing its use by teachers. Study bias was mitigated by not utilizing the developers of the technology to be involved in the data collection or the observation. Additionally, we began continual conversation with the research participants and presented our analysis to them for a form of “member checking” to ensure that our conclusions mirrored their own experiences with the technology.

Data Analysis

The primary data used for this study were the uploaded videos and comments generated from participants within the MathVision application. These were analyzed by the research team to understand the evolution of the professional knowledge that teachers exhibited through and with the application. This analysis involved continual watching and reading of this data, research team meetings to discuss our interpretations, and member-checks back to the teachers in the final interview. The secondary data involved video observations from the classroom. This data was analyzed through a grounded theory methodology (Corbin & Strauss, 2008) in order to notice any emergent themes that inform us as to how teachers and students utilized (or did not utilize) the technology.

Results

Our analysis uncovered the following results to our research questions. First, to answer how a VPLC environment might be created that enables elementary mathematics teachers to base their teaching on research-based mathematical Learning Progressions, without requiring timely and resource-heavy physical interactions between teachers, we found that this was possible through mobile technology. However, a larger finding was that teachers did not actually use this technology to house their discussions. For instance, teachers primarily focused on the novel ideas associated with doing individual task-based interviews with their students rather than having collective discussions about their respective strategies and aligning them to the learning progressions. The discussions themselves that emerged as a result of these task-based interviews were primarily done physically rather than through the web-based application. The technology itself was mainly used as a place to sore and retrieve the videos in an easily accessible way.

Second, to answer the question of what affordances of MathVision teachers utilized and how these features affected their teaching practice, we found that teachers did not actually engage in watching each others videos prior to their physical meetings, but rather used the meeting time to watch and discuss each others videos. It seemed that the physical meeting space afforded teachers the ability to meet, think about and discuss the video data itself. We ponder as to whether that had teachers a specific timeframe to upload and view/comment on each others videos might have been beneficial in accomplishing prior commenting.

Finally, in asking how will physical team-meetings be altered or augmented through the use of this technology, which allows teachers to view each other's videos before these meetings as well as how will teachers interact and talk to each other in reference to the technology, we found that teachers collaborated within this VPLC environment, teachers seemed to support each other through the process, but that seemed to be primarily due to the collaborative infrastructure that previously existed in the school. However, teachers indicated that the videos unveiled a level of depth into each student's individual thinking that they had previously not seen.

A number of results also emerged with respect to enhancing student learning. In particular we found that the instructional decisions and discussion that teachers had with each other about supporting the needs of their students, based on the strategies they saw, were important as they uncovered student conceptions related to solving particular length and measurement problems. In response, the teachers hoped that more instructional tasks could come about from this experience to support learning in this area.

As a result of this study we also observed that the teachers did engage in significant conversations about student learning process and their alignment to the research based learning progressions. This is one area that we feel may be appropriate for future inquiry.

Discussion

Overall in looking across these findings we offer the following overarching results. First in consideration of the proof of concept of this study we observed that it was possible to build a functional interface for teachers to have meaningful discussions about student strategies and align them to the CBA framework. However, with respect to this mobile application, we found it still very difficult for teachers to utilize for a number of reasons. First, the selection of length and measurement as a focus caused some difficulty, as this was not aligned to the current content they were teaching and treated more as an “add-on” to their already busy schedule. Additionally because the technology platform was still in a “beta” phase of development, the platform did not always perform as it was envisioned, particularly as teachers access to it over the school’s WiFi wavered during the course of the study.

Additionally, the small-group meetings where the learning progression alignment was discussed were not consistent across teachers. When teachers were in the same physical space, there was seemingly less motivation to challenge each other’s lines of reasoning and agree on a particular level after only a short explanation. With the drive of the interface as being to produce a space for disagreement and reconciliation of those disagreements through productive chat, this is something that we had hoped would arise through the use of the application. Furthermore there was a considerable number of interviews conducted by a relatively small number of teachers with one teacher in particular conducting a much larger number than others due to the busy schedule of the participating teachers. We question how our observed interviews would have been different with additional teacher voices conducting the interviews.

One other result was that the teacher who was presenting her own students’ strategy often felt a sense of pride and ownership in the student’s mathematical thinking. Teachers reflected that when their peers critiqued or commented on their students’ thinking, their first reaction was often to take it as a personal critique and not a learning opportunity. Perhaps the immediacy of watching video on one’s own mobile device or tablet instills a sense of ownership or connection to the student.

While teachers were excited and motivated to pilot this web-based application, we wonder as to the extent that which VPLC’s were actually established, as there was initially little dialogue that occurred online. Rather simply participating in the study and having a home for the relevant video data sparked physical discussion on students’ levels of reasoning and actually was able to bring out instances where students who were deemed as being high performing fell apart on tasks due to the nature of the CBA tasks. In one particular example, a young male student “Dylan”, a pseudonym, responded incorrectly on a measurement task with an incorrect line of reasoning. Initially the teachers had wanted to dismiss this as a poor interview, but later realized that they were uncovering quite a bit of detail on the students’ line of mathematical reasoning.

We did uncover some positive results with respect to using this interface during the course of our study. Teachers reported that this experience was helpful to their teaching practice, in particular in being able to watch and talk about each other’s recorded videos. Teachers also felt this project connected strongly to the existing practices they see in other educational roles, in particular with their Reading Recovery program, in which they present student reading and work to the team of teachers for discussion. Further, through conducting these interviews, teachers were able to get a better understand of their students’ lines of thinking as well as increasing familiarity with other teachers’ students. Finally, and arguably most important finding, the teachers felt they gained significant knowledge in mathematical interviews and learned much about the learning progressions. As a result of this, our teachers reported that they had to question their own assumptions of mathematics learning and achievement and would be better equipped to use the learning progressions in their own teaching.

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