Constructing Multimedia Artifacts with Pre-Service and In-Service Teachers: Problem Solving in a Heterogeneous Technology Learning Environment

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Abstract: Multimedia artifacts, capable of simultaneously showing and telling a story, provide a unique opportunity to make thinking and reasoning visible. As students, educators, and researchers engage with these rich artifacts, they navigate multiple technologies. Our studies explored pre-service and in-service teachers' use of a large video repository to create multimedia artifacts that integrate text editing and video technologies. Exploring the problem solving that occurred throughout the design and implementation of two studies of students collaboratively creating multimedia artifacts, we consider in this proposal how to organize multiple forms of technology as seamlessly as possible. In our description of the technical and pedagogical design challenges we faced and the solutions we devised, we work to offer suggestions for researchers working in similar learning environments.

Keywords: Multimedia artifact, pre-service teachers, in-service teachers, technology, design

Introduction

Multimedia artifacts, capable of simultaneously showing and telling a story, provide a unique opportunity to make thinking visible through the integration of several technologies in order to create a final product that can be shared with others. Our work investigates the creation of a multimedia artifact by pre-service and in-service teachers in two disciplinary contexts. As students engaged with the rich artifacts in our two studies, they navigated video archives, a complex video annotation tool, and collaborative note-taking technology. The challenges we faced integrating this multimedia technology into classroom contexts are shared here to inform future design and development. The specific technologies used in this study include the RUanalytic tool, a video annotation tool that draws upon video within the Video Mosaic Collaborative video repository (VMC, http://www.videomosaic.org; Agnew, Mills, & Maher, 2010) and collaborative text editing platforms. The VMC is an extensive repository of video collected during longitudinal and cross-sectional studies of mathematics learning. Users of the RUanalytic tool create "events" by importing, clipping, and annotating video from this repository of classroom video. Each event is accompanied by a text description and placed on a timeline to play sequentially. The multimedia artifact produced (called a VMCAnalytic) can then be shared with others (see Figure 1). The RUanalytic tool, currently used to annotate video from several repositories, is one of many video annotation tools increasingly brought into classroom environments, making the lessons we've learned applicable to a variety of settings.

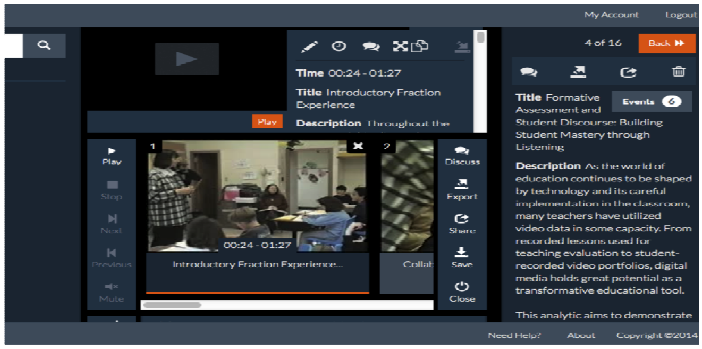

Figure 1. VMCAnalytic Multimedia Artifact

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We have previously studied how the VMCAnalytic provided a window into student thinking and provided suggestions about ways in which learner goals and constraints might influence how people construct these artifacts (Hmelo-Silver et al., 2014). To gain further insight into the affordances of this unique tool for a population of pre and in-service teachers, our current studies developed interventions using the tool in two university classrooms: an Educational Psychology context and a Mathematics Education context, each at separate universities. Using one multimedia tool (the RUanalytic tool,) these pilot studies explored the ways in which pre-service teachers apply the content of coursework in the construction of multimedia artifacts.
The application of theory to classroom observation is an authentic learning task for pre-service and in-service teachers that will come up in the creation of teaching portfolios and in the evaluation of teaching practice. Working with the RUanalytic tool, learners are able to explore video that features a real classroom context. This process is consistent with the goals of cognitive apprenticeship to enculturate teachers into professional ways of viewing their classrooms (Brown, Collins, & Duguid, 1989; Goodwin, 1994). As previous studies have shown, video analysis is a useful tool for understanding what teachers know, as well as how they reason in classroom scenarios (Sherin & van Es, 2005; Sherin, 2007). Here, in the Orchestrated Collaborative Classroom Workshop track *Linking Pedagogy and Heterogeneous Technological Resource Ecologies* track, we focus on the anticipated and unanticipated challenges uncovered in the design and implementation of video analysis interventions for pre-service and in-service teachers. The guidelines discussed in this paper were designed based on our experience with the RUanalytic tool, but they may be applicable to similar research in which video and video annotation tools (e.g., WebDiver) are utilized.

Throughout our pilot studies, we addressed a general wicked problem: How do we take advantage of a complex and heterogeneous set of video resources and analysis tools in a principled way to support learning for multiple contexts and disciplines?

Overview of Mathematics Education and Educational Psychology Contexts

The Educational Psychology course we targeted for our VMCAnalytic intervention had a population of pre-service teachers. This course introduced students to fundamental theories about learning. Our intervention was designed to provide students the opportunity to apply the concepts they'd covered throughout the semester to an analysis of VMC video. We conjecture that providing early experience with video from other settings will help better prepare pre-service teachers for the future task of analyzing video of their own teaching, and will help pre-service teachers to see the relationship between theory and practice.

Interventions using the RUanalytic tool also took place over three semesters in an Introduction to Mathematics Education class for pre-service and in-service teachers. The learning goals of the course centered on recognizing students' reasoning as they solved combinatorics problems throughout K-12 education. Pre-service and in-service teachers in this course were asked to create a VMCAnalytic that demonstrated course learning goals, which focused on attending to students' mathematical reasoning. At the end of each implementation, the research team studied the multimedia artifacts produced by the students, and made adjustments to the class in order to better situate the assignment.

Challenges

Working within a multimedia space, our research teams were challenged to develop crosscutting design principles for two different learning contexts. These overarching challenges are broken down into pedagogical and technical categories. We will unpack the solutions that arose in each learning environment—highlighting how these solutions might inform future CSCL work across contexts.

Pedagogical Design

In both Mathematics Education and Educational Psychology, our research teams endeavored to design tasks that matched learning goals and course contexts. Implementing the same multimedia tool in different environments, it is necessary to adapt in order to best meet the needs of a specific community. This adaptation requires assessing the overarching learning goals of the task, the level of students working with the set of tools, and the available timeline for the intervention.

Throughout our process using the VMC repository and RUanalytic tool as an intervention across contexts, we found that designing for learning goals and specific contexts required the introduction of a set of carefully chosen constraints. These limitations included the assignment of specific video clips to work with, thus narrowing the students' search space, and delineating a number of events in a multimedia product. The

researchers worked closely with instructors in the selection of video clips to incorporate into their courses. This gave teachers the opportunity to draw from a narrowed set of videos and to explore the VMC and RUanalytic tool. Establishing constraints makes the activity more manageable for student *and* instructor. Focusing the task at hand in this way provided students the space to show their thinking, while keeping the time needed for assessment reasonable.

Technical

In conducting the interventions, our research team worked through technical issues including the challenges of multiple log-ins, difficulty hearing audio in video recordings, and unreliable Internet connections. These challenges were not as salient as our pedagogical design challenges, but did influence the refinement of learning goals and tasks.

Problem Solving in these Spaces: Meta-principles

Solving Pedagogical Issues

Across the two contexts, pedagogical design principles were addressed through the design of tasks with built in constraints. These constraints can be summed up by three meta-principles:

- Constrain student search through limiting the video for creation of artifacts
- Provide clear expectations for number of events
- Adapt to address meaningful learning goals and pragmatic issues for particular contexts

In the Educational Psychology course, each group of 3-4 students was assigned a different video clip, between 6 and 13 minutes in length. Videos were selected by the research team based on the presence of theories covered throughout the semester. Students were provided with a 20-minute VMC and RUanalytic tool tutorial developed and implemented by their course instructor, and were directed to limit VMCAnalytic multimedia artifacts to three events. Here, our designed constraints allowed students to create a first draft VMCAnalytic within the first class session, and gave students the opportunity to work in small groups during a second session to compare VMCAnalytics made from the same video. Students vocalized that they appreciated first working independently and then with a group because it helped them to discover that there are many learning theories applicable to a single classroom moment. The needs of the learning community were addressed through the consideration of teacher performance assessment guidelines in task design, and attention to the skill of applying theory to practice that recurs throughout a teacher's career.

In the Math Education context, the design principle of built-in constraints was addressed through the decision to have students explore video *before* constructing a VMCAnalytic, and through efforts to provide a meaningful context for VMC videos. Throughout the semester, various learning theories (e.g., constructivism), educational practices (e.g., teacher questioning), and frameworks (e.g., problem-based learning), were explored through class readings, discussions, and video. For the VMCAnalytic project, the students were encouraged to use one of these ideas and to map it across videos that were found in the repository. Students experienced a unit in their course devoted to learning to use the VMC and RUanalytic tool. The use of the RUanalytic tool was integrated throughout the 15-week course. Our analysis revealed that students who started with a video, studied the video in depth, and then tried to map the video to a topic covered in class were more successful than students who started with an idea and tried to find a video to match it. Students who started with understanding a video in depth first and *then* mapped it to the idea of teacher questioning were better able to construct coherent narratives about teacher questioning.

Adapting our activity to address meaningful learning goals for a Mathematics Education population concerned with development of mathematical reasoning, it was important to help the students situate VMC videos chronologically. Each video contains metadata with student grade level, school, and recording date. Students often ignored metadata and ordered clips to fit an argument. Explicitly pointing out the metadata features did not help to alleviate this issue. The choice to constrain students to a small number of videos to work from helped to address this problem.

Solving Technical Issues

Four meta-principles were developed with regards to technical issues, and although some of these seem obvious, they need to be addressed or they may overshadow the pedagogical and research goals:

- Anticipate issues of bandwidth and connectivity
- Prepare students for using the technology
- Expect issues related to logging in with heterogeneous technologies
- Capture student work dynamically

Across both classroom contexts, working in a computer lab with wired Internet connections assured ready access with adequate bandwidth for multiple computers downloading video. When it is not possible to gain access to a wired connection, a hot spot wireless connection may be brought in to increase bandwidth. We also found it important to anticipate problems with multiple log-ins. In our Educational Psychology context, students were given the opportunity to become familiar with basic navigation of the RUanalytic tool via a tutorial experience, and began creating events that connected to theory they had learned in class in their first session working with the tool. In our next intervention using the RUanalytic tool, we will make it an assignment for students to log on to the tool in advance of their in-class session. In working with complex online tools, it is ideal to have students explore the tool outside of class in order to use face-to-face class time efficiently.

For our research goal, we wanted to capture the processes of constructing the multimedia artifact. To accomplish this, all version histories of VMCAnalytics were saved through digital archives. This allowed researchers to track changes in each student's VMCAnalytic and changes over time. We also used Etherpad and eCollege, tools that allow collaborative editing of text documents, to further track group reasoning processes. Students were asked to take notes on their feedback for each group member in our Educational Psychology intervention. We therefore had a clear record of what occurred in the groups we were not directly observing, and we were able to confirm inferences made when we tried to understand what was happening in group videos with poor audio quality.

Conclusions

As the use of video and video annotation becomes more prevalent in pre-service and in-service teacher development, video repositories and annotation tools can be invaluable, but they must be understood as complex. In designing interventions that integrate heterogeneous video technologies, our research team recommends a) consideration of the learning goals of the context in which the tools are utilized with attention to the needs of the specific learning community, b) the introduction of appropriate task constraints including limiting the number of video choices and the length of video clips, c) technical support for the course instructor and students through video tutorials, help documents, and in-person tutorials, and d) anticipation of technical challenges including internet connectivity and small group work logistics. Drawing upon our experiences in two different disciplinary contexts, the careful setting of parameters helped to direct students' attention within a new set of technologies in order to direct attention towards meeting learning goals rather than becoming caught up in the details of negotiating multiple technologies.

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