Using Web 2.0 Interactive Rich-Media Technologies in Mathematics Teacher Development

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Abstract: This roundtable session aims at showing how to exploit interactive rich-media technologies, especially technologies for watching and annotating animated instructional stories, to support teacher learning. We consider that watching and annotating representations of teaching done with animated cartoon characters may help teachers focus on noteworthy moments, and therefore learn to notice critical events of teaching practice. We also consider that telling and sharing teaching stories may help them exchange the professional practical knowledge that makes their actions meaningful and guides their learning. In this session, we show three virtual settings for sustaining teacher learning: a virtual space for teachers to watch and comment on a variety of animated instructional stories in geometry, an online environment for teacher groups to watch and discuss those stories, and a web-based lesson composer for teachers to create and share their stories. Also, we briefly report on how that kind of online environments helped teacher development.

Context and objectives

Evidence from project ThEMaT (Thought Experiments in Mathematics Teaching) indicated that animated instructional stories are effective at prompting discussion among experienced teachers and at eliciting the rationality they put to play in action, and therefore may help them develop their practice (Herbst & Chazan, 2003, 2006). Indeed, the animations provided opportunities for teachers to share and discuss their common practical knowledge of their profession, and hence learn about different alternatives to a given teaching situation or problem. Animations of stylized cartoon characters eliminate many of the "noisy" elements often present in video records, and this may help teachers focus more on noteworthy events while they are watching and annotating animations (Herbst & Chazan, 2006). In addition, the animations constructed in the context of ThEMaT were intentionally designed in a manner that they contain breaches of what is hypothesized to be normative. Experienced teachers responded to those breaches by creating alternative courses of actions, which have happened or could happen in their own classrooms, and therefore disclosing information about the implicit norms that regulate their professional practice (Herbst & Miyakawa, 2008; Herbst & Nachlieli, 2007; Miyakawa and Herbst, 2007a, 2007b; Weiss & Herbst, 2007).

Building on the success of project ThEMaT, we are developing several virtual settings that can be used to support mathematics teacher learning. The core technology remains the use of animated representations of teaching, but we now embed the animations in a web-based environment to make them accessible more widely and more conveniently. To provide the teachers with more active learning experiences we make use of interactive Web 2.0 technologies, which allow the teachers to easily collaborate, produce, publish, and share their own contents, and rate and comment on others’ contents (Wesch, 2007). We also apply different methods, according to design-based research (Brown, 1992; Collins, 1992), to perform a series of studies during the development process. This iterative and self-correcting process provides an optimal path (Rieber, 2005) toward the implementation of complex virtual settings for teacher development.

In this roundtable session, we first summarize an empirical study we performed to evaluate a couple of online experiences implemented in the first cycle of the development process. Then, we present and discuss the following three virtual settings, as the results of the revisions of the first cycle: (1) a virtual space in which teachers watch and comment on various instructional stories in geometry, (2) an collaborative environment in which groups of teachers watch and discuss one of those stories in forums and
chat rooms, and (3) a web-based lesson composer that allows teachers to create and share their own instructional stories.

**Study of online experiences**

We developed two online experiences; in each experience, teachers participated in a series of consecutive activities. In the warm-up activities of both experiences, the individual teacher views a clip from the beginning of a lesson and a clip from the end of the lesson; then, they are asked to respond to questions about what might happen in between; finally, they view the full story, and are invited to comment on the story. In the second experience, the individual teacher also views three clips representing three noteworthy moments of the story, and responds to a few questions related to each moment. Those warm-up activities are designed to facilitate interactive communication in the form of an asynchronous forum and a live chat. In the forum of the first experience, three discussion threads are provided in advance. Each thread corresponds to a noteworthy moment of the story. In each thread, a clip representing the moment is embedded and several questions are presented. Those moments and questions are the same as those used in the second experience. Teachers collectively respond to questions and discuss moments. A moderator is present in the forum. They can view the embedded clip and the whole story with full control at any time. They can add other discussion threads. In the chat room of the second experience, teachers and a moderator use a text-based chat to discuss the story. The animated story is embedded so that they can view the story with full control at any time. Both the forum and the chat room are organized in a traditional way (see www.atutor.ca). The novelty of those online experiences is that animation clips are embedded in the communication tools to stimulate discussion.

Nine in-service mathematics teachers were organized into two virtual groups: four in the first experience and five in the second experience. Each participant used a laptop to explore their experience during two hours while located in separate rooms. After exploring their experience, all participants in the same virtual group gathered together in the same physical space to talk with researchers about their experience. We asked questions about the usability, usefulness, and effectiveness of the online experiences. Because they had all participated previously in ThEMaT’s face-to-face study groups, and were thus familiar with the animations, the questions and comments focused on the experiences of viewing and discussing the materials online. A similar study was conducted with eight pre-service mathematics teachers: four in each experience. They had also previously seen ThEMaT’s animations and discussed them in a teacher education class.

The main result of the study has been that the two online experiences with the support of animated clips helped the participants notice critical events of the embedded instructional story, that is, they focused, for example, on the teacher, the students, the mathematical ideas, the pedagogy in their discussions. Details of the study are given in Chieu, Weiss, and Herbst (2009). Noticing significant features in instructional stories may help teachers build a shared domain of knowledge, including specific practical knowledge, that makes their actions meaningful and guides their learning and a community that helps sustaining interactions and relationships based on mutual respect and trust. Those are essential elements for creating a community of practice (Wenger, 1998). The study also provided a number of suggestions for the improvement of the user interface as well as of the functionality of the tools used in the online experiences. For example, it would be better to organize the forum in a logical manner than in a chronological one so that the users can easily follow different discussion stories. Additional rich-media tools should be added to the forum so that the users can share, for instance, diagrams and files. We have revised those suggestions and we have been developing a second set of virtual settings, part of which is illustrated in the following sections. We continue to expect that those virtual settings may help teachers better learn to notice critical events of teaching practice and to share and give feedback on their professional practical knowledge, which is important for them to develop their profession (Connelly et al., 1997; van Es and Sherin, 2008).

**Exploring animated instructional stories freely**

In this virtual space (for the time being, it is available at www.grip.umich.edu/themat/ only for researchers or university-based teacher educators), we provide users with about ten animated lessons, some of which may have different versions and/or alternate endings. Those lessons and their alternatives cover a variety of instructional problems and situations in geometry teaching.
The individual user chooses any animation and watches it with full control over the video (Figure 1). The user can pause the animation at any moment in the timeline and make a comment on that moment. As showed in Figure 2, inputs for the comment include text with formatting options available, emoticons, and user-created diagrams (the user interface includes a web-based drawing tool). The user can also attach a file, such as an image of student work, to the comment. The small icons next to the first comment showed at the top left of Figure 1 represent an attached diagram and an attached file. During the exploration of the lessons, the users can go to an online forum and freely discuss what they have noticed with other users who navigate in the same virtual space.

**Figure 1.** Watching and annotating “The Square” (not an actual use but a demo)

**Figure 2.** A rich-media tool for the users to input rich text and attach diagrams and files
The learning experience we support in this virtual space is a kind of free exploration, in the sense that the users can give any sort of comments at any moments of the animation being viewed and they can talk about any topics in the forum. We believe that this learning experience is useful because it helps the users comment on and discuss any events in our animations that they think noteworthy in the practice of teaching. As mentioned before, because a number of breaches are installed in each animated lesson, we expect that users would be able to notice those breaches and discuss and learn about alternative stories around those breaches.

**Exploring animated instructional stories in a more structured way**

We provide teachers with an online environment in which learning activities are more structured than those in the previous virtual space. In this learning experience, teachers focus on only one lesson — selected, for example, by a teacher educator.

The individual teacher first engages in several “warm-up” activities. In addition to the activities we described in the first study, we add several new activities. For instance, after each question activity, the teacher may put flags on their own noteworthy moments and may give comments on those moments later on, in a manner similar to the commenting activity in the first virtual setting.

After completing warm-up activities, the teacher will be directed to an online forum or chat room where s/he can discuss the animation with other teachers and/or the moderator (see the second section). The new features of the forum (Figure 3) include the tools allowing the users to attach one of our clips to their own threads, to attach a diagram or a file to their messages. The forum is organized in a logical (or tree) structure. When the users input a time code in their message (e.g., 3:46), the system automatically detects that time code and makes it playable (i.e., when one clicks the time code, the player on the left hand side of Figure 3 will play that moment).

![Figure 3](image.png)

**Figure 3.** An interactive rich-media forum of “The Square” (not an actual use but a demo)

We think that this second kind of learning experience is complementary to the free exploration described previously, in the sense that users may deepen the discussion into specific issues of teaching practice such as a particular teaching tactic or a misconception of a particular student, which could be identified by the teacher educator and/or the moderator in advance.
Creating and sharing slide-based instructional stories

The previous two virtual settings provide users with various opportunities to actively explore our animated lessons. They give, however, little support for them to tell their own instructional stories. To fill that gap, we have been developing a web-based lesson composer allowing the teachers to create and share slideshows that represent their own lessons. A preliminary version (Figure 4) is available at www.grip.umich.edu/themat/, accessible with the guest account.

Figure 4. User interface of a graphics-based lesson composer (not an actual use but a demo)

To create a slide, the individual teacher can use a set of virtual classroom templates in which a teacher cartoon character and a number of student cartoon characters are inserted in a classroom background. There are both teacher-view and student-view or board-view templates. In board-view templates, a whiteboard is visible. The teacher can insert content (e.g., text, diagrams, formulas) into the whiteboard by using a web-based drawing tool. The teacher can also add facial expressions to and adjust arm positions of the animated students. To create interactions between the animated teacher and the animated students and among the animated students, the teacher can use speech bubbles. The teacher can add captions to each slide as well.

The teacher can view and edit the set of slides as many times as s/he wants. Finally, when the slideshow is ready to be shared, the teacher can publish his or her slideshow in a web space. We provide the teacher with a URL and an embed code, in a similar way YouTube has provided its users with video links, so that the teacher can embed or share his or her slideshow in any web space s/he wants. We also provide the teacher with a forum so that s/he can share the slideshow with other teachers who use the same lesson composer. The point here is that the teacher can get feedback from colleagues on his or her own lessons, and thus learn about different alternatives to a given teaching situation or problem.

To make connection between this third activity with the previous two ones, we plan to embed the lesson composer tool in the previous two environments so that the teachers can create and attach their alternative stories, for example, to the breaches installed in each of our animations.

Future work

In the future, we plan to develop more advanced cognitive tools for teachers to use while they are interacting with teaching artifacts and with each other, for example, teaching simulations and role-playing
games. We also plan to provide teachers with intelligent support to help them optimally benefit the available resources and tools. For example, while the teacher is planning a lesson, the intelligent support agent can provide him or her with appropriate resources such as mathematical ideas, students’ conceptions, teaching tactics, according to the planning problems with which s/he is confronting.

The second cycle of the development process has also provided us with an approach for the development of an authoring tool allowing teacher educators to create their own online experiences for their students. For example, they can define parameters for activities: the animated story to be used, the critical moments of the story to be discussed, the questions for those moments, controls of the video player for each activity, when to activate revision, flagging, forum, chat activities. In other words, they can define fine-grained parameters for each of the activities and the arrangement of them, in a similar way workflow software, such as Mac Automator, has offered to its users.

Endnotes
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References


