Grounded in Theory: Immersing Preservice Teachers in Technology-Mediated Learning

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Abstract

The integration of technology into preservice teacher education continues to be emphasized as important. The hope is that if future teachers obtain technology skills they will design meaningful technology-mediated learning experiences for their students. However, gaining technology skills alone does not ensure the ability to envision and employ successful technology-mediated learning designs. Consequently, teacher education must model the connection between learning and technology. This paper examines the use of digital stories as a pedagogical tool in two undergraduate educational psychology classes. The study analyzes a constructivist learning design where technology and learning intertwine. Affordances and constraints of learning within this design are explored in relation to student experiences. The analysis includes artifacts such as wikis, storyboards, a questionnaire, and their final digital stories.

Embracing and Envisioning Technology Integration

The integration of technology into preservice teacher education continues to be considered important (National Council for Accreditation of Teacher Education, 2002). Some researchers assert that if future teachers obtain technology skills they will design meaningful, technology-mediated learning experiences for their students (Koehler & Mishra, 2009). Some researchers maintain that integrating technology into regular teacher education courses is essential (Gunter, 2001; Strudler & Wetzel, 1999). Further, it is important that technology be intertwined with course content and assignments

(Vannatta & Beyerbach, 2000). Positioning technology as separate from regular teacher education courses translates to the notion that technology is a skills-based discipline that is discretely conceptualized outside of the context of learning.

Disconnected from content, technology classes do not necessarily provide preservice teachers with the modeling they need to think successfully and critically about how technology supports teaching and learning within their disciplines. Exposing preservice teachers to classes in this manner risks a perpetuation of technology use to replicate traditional models of classroom practice (Ertmer, 2005; Strudler & Wetzel, 1999; Willis, Thompson, & Sadera, 1999). Conversely, integrating technology into coursework has moved teachers to adopt more student-centered and constructivist practices (Roblyer & Edwards, 2000).

Learning sciences researchers emphasize that learning to teach with technology should not result in the reproduction of current educational practices. This group draws on the current research related to how people learn to ground their "deep commitment to radically transform learning – away from the transmission and acquisition style associated with lectures and quizzes, to a more active, participatory learning style" (Kafai, 2006, p. 35). For the learning scientists, this style takes constructivist forms such as constructionism (Kafai, 2006), case-based reasoning (Kolodner, 2006), knowledge integration (Linn, 2006), anchored instruction (Cognition and Technology Group at Vanderbilt, 1990), and project-based learning (Krajcik & Blumenfeld, 2006), to name a few. These learner-centered (Quintana, Shin, Norris, & Soloway, 2006) designs include not only technology, but also curriculum and technology comprehensively working in concert to support learning, instruction, and assessment (Linn, 2003).

This emphasis on combining curriculum and technology as an interconnected learning design is important because it is often asserted that technology alone has the potential to transform the classroom (Ertmer, 1999, 2005). What has become increasingly apparent, however, is that learning designs are the foundation of such transformations (Sawyer, 2006). Within these designs are examples illustrating how technology highlights the benefits of transformational learning and mediates the possibility for them.

The charge of teacher educators is to design and model constructivist learning experiences that fully engage students in the effective use of technology to support these designs. Experiencing designs that reflect learning sciences research within the core courses of preservice teacher education programs is one way to model authentic intersection of technology and learning within the context of learning. Using this context is supported by research suggesting that the way preservice teachers are taught greatly affects the way they teach (Becker, 2000; Niederhauser & Stoddart, 2001; Norum, Grabinger, & Duffield, 1999).

Moreover, actively engaging in constructivist learning designs with and through technology will afford students the opportunity to see and feel how such engagements play out in their own classrooms. The likelihood that preservice teachers will be better prepared to create technology-mediated designs in their own classrooms will, thus, increase (Richardson, 2003).

The purpose of this paper is to share my response to this charge by using digital stories as a pedagogical tool for learning. The history of digital storytelling in education and several theoretical foundations informing my design, which employed elements of constructivist learning supported and mediated by various technologies.

Ultimately, students created a digital story to construct and demonstrate an understanding of four learning theories. While building these stories, students used wikis, storyboards, and digital stories to actively learn about their topics. In doing so, they embedded facts and concepts within the context of building knowledge. This learning design was intended to model the interrelationship between constructivist learning and technology use. The question for my inquiry was how do students participate in and react to this learning design? Specifically, what are the affordances and constraints for their learning in this type of engagement?

Digital Stories in Education

Digital storytelling has recently become a popular pedagogical tool. For example, some educators use digital stories as a way to motivate students to write. This strategy has been relatively successful for struggling writers and especially students with disabilities (e.g., Michalski, Hodges, & Banister, 2005). In addition, digital stories help students increase their writing quality and creativity (Lambert, 2007, p. 25). Art educators view digital storytelling as an effective way of bringing art into the digital era (e.g., Chung, 2007). Teachers also use digital stories to reflect an earlier art form. Oral histories, a tradition of native cultures, are now documented in this new medium. Native narratives are a historic art form that ensured that stories originated from and were passed through the cultural sources of the community (Hopkins, 2006). The purpose of those narratives was to transfer cultural and social values of the tribe (Spierling, Grasbon, Braun, & Irgel, 2002). In each case, the research connotes that digital stories assist students in gaining academic skills while representing ideas in the form of images, sounds, and text.

In my own work in informal learning environments, I have observed how that, while creating digital stories, learners' digital productions have become active engagements with content, context, and peers (DeGennaro, 2008). In that informal environment, students built digital stories that connected to issues in their communities. During the process, students made a concerted effort to better understand, illustrate, and represent ideas that brought their stories to life. Coming to understand the ways in which students interacted with content and story creation caused me to consider the effectiveness of this activity in a content-based learning environment. This experience inspired me to generate ideas about how to bridge this work in informal learning environments with preservice teachers, and I crafted a digital storytelling project for my two Psychological Foundation of Education classes.

Grounding the Learning Design in Theoretical Frames

Preservice teachers need modeling of and engagement in constructivist practices that explicitly use technology to support teaching and learning. Therefore, my design did not lead with the technology, but rather brought technology directly in line with learning. Theoretical grounds for my learning design included the concepts of knowledge building (Scardamalia & Bereiter, 1991), mediating artifacts (Vygotsky, 1978), and spatial representation and imagery in learning (Schwartz & Heiser, 2006).

The notion of knowledge building suggests that students work in communities actively to construct an understanding of concepts, facts, and skills. Knowledge building requires that learning be situated in real-world questions or problems. In this theory, students draw on previous knowledge and make connections to new knowledge. Students begin to formulate and question new ideas and knowledge as they work across people and tools (Hutchins & Klausen, 1996). With this in mind, my design included a real-world scenario or problem.

As students work across people and tools, the aim is for them to build a common understanding about authoritative information. Rather than accepting authoritative knowledge, students are encouraged to question it and apply it. Students negotiate and create expressions of ideas in their own words and based on their own experience. In other words, students work toward developing a relationship with the content. This relationship, according to knowledge building theory, implies that learning is mediated in the interactions across people and tools.

I understand *mediating* to mean something that acts in the middle or between learning (Roschelle, 1996). Mediating tools are nodes of participation, thinking, and negation, where students begin to try out and interact with ideas. One object of mediation implicit in knowledge building theory is the creation of artifacts and the representation of ideas.

Artifacts could be conceptual ideas, such as theories. Conversely, they can be physical objects in the form of three-dimensional models. In designing artifacts, learners experience knowledge growth as they test and organize ideas and convert them into some conceptualized form. In their creation of artifacts, students need to investigate, question, reflect upon, and find ways to express this knowledge (Scardamalia & Bereiter, 2006). Also inherent in this theory are the characteristics of idea improvement, knowledge *of* rather than *about* concepts, and organizing meaning around problems instead of topics.

Based on this theoretical foundation of learning, my design included a means by which students work in a community. In this community, available resources mediated knowledge building. Using digital tools as support to mediate learning helped to facilitate mutual understanding of content (Stahl, 2000). Wikis came to mind as an effective mediating tool. The wiki was a space where participants could co-construct meaning and create new knowledge (see Figure 1). Moreover, this space allowed students to formulate, articulate, and talk around their ideas (Vygotsky, 1978).
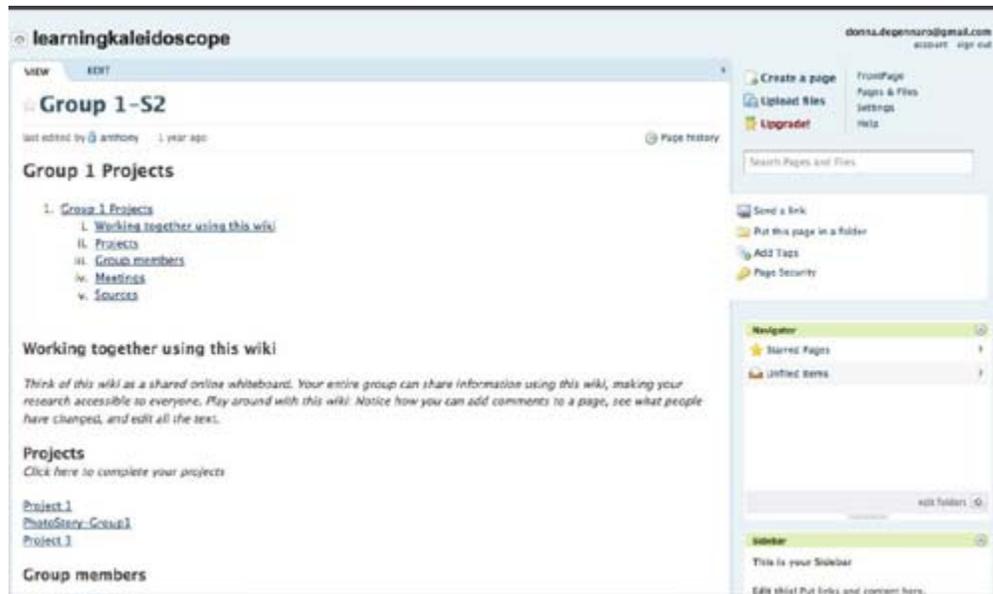
Figure 1. Screenshot of wiki.

Finally, wikis became a location to capture knowledge building so that students and instructors could formatively assess the process. Here instructors could also easily support the learning community and provide direction of the conversation when necessary. The wiki design provided structures that assisted students in activating prior knowledge and organizing them within new concepts (Bransford, 2004). For example, spatial representations (storyboards for example) could be useful in providing structures that make learning more effective and durable (Schwartz & Heiser, 2006).

While constructing knowledge in the wikis, students kept in mind that the ultimate intent was to build a digital story. In order to connect this process explicitly with eventually creating digital stories, the students were asked to think of images that represented the kinds of knowledge they were creating (see figures 2 and 3). Once the images were collected, students used a storyboard to plan the sequence of their digital story as well as map out the sounds, text, and voiceovers that would accompany the story.

This process had a dual purpose. Not only would these images potentially become components of their digital stories, but they also reflected the notion that people have expansive memories for pictures (Standing, 1973) that greatly exceeds their memory of words and sentences (Shepard, 1967). In the same light, connecting images with mental conceptualizations and other textual elements helped students structure ideas and better internalize them (see Marcus, Cooper, & Sweller 1996).

These were the foundations of my initial learning design and the reasons for the use of the additional technologies to scaffold the completion of their digital productions. These theoretical underpinnings guided my design and informed my analysis of the implementation.

Methods

Context

Students. The context of this study included preservice undergraduate students in two core educational psychology classes. Students in these classes ranged from freshman to seniors. There were two sections of the course. One was comprised of 29 students and the other, 31. These students engaged in a constructivist design that utilized technology as a central part of learning. The students used digital storytelling as a pedagogical tool to facilitate their first exposure to learning theories. To support their projects, they used wikis as mediators of knowledge building in order to create knowledge about content. They then constructed collaborative digital stories to represent the theories.

My role. In this context, I was the professor and the researcher. As a teacher, I identify myself as an educator who employs disruptive learning designs. I define disruptive learning designs as learning environments that challenge traditional modes of practice and push participants beyond their comfort zones.

Adopting the notion of being disruptive is often a difficult concept for students. In particular, students frequently expect me to unambiguously define the learning goals, expectations, and details of assignments. Conversely, I believe my students should construct knowledge with me and with their peers. Students engage in ill-structured learning environments to facilitate the co-construction of knowledge. "Ill-structured problems are those where the initial situations do not provide all the necessary information to develop a solution, and there is no one correct way to solve the problem" (Chin & Chia, 2005, p. 46).

This design feature is based on two principles. One is to emulate the ways in which students communicate with both adults and peers in informal technology-mediated learning environments. The next is to foster an experience of being responsible for individual and collective learning. In order for aspiring teachers to use technology successfully to support teaching and learning, they must experience such learning designs. Thus, I must build a culture of trust in my classes. Students are encouraged to say what they feel and be honest with me without fear of penalty of any kind. As a result, more often than not, the data that I collect from my classrooms seems authentic in terms of students' honesty about their experiences.

Learning goal. The learning goal of the 2-week digital storytelling project was for students to develop an understanding of four foundational learning theories: behaviorism, cognition, social constructivism, and constructivism. The overarching goal of the project was defined as follows:

> Your team will create a presentation for the board of education. In the form of a Digital Story, your presentation will utilize visuals, sounds, and text to illustrate various aspects of particular learning theories. You are addressing the question: "How is each of these learning theories effective for teaching and learning?" Your story must portray the following aspects of the topic: Role of the learner, role of the teacher, design of the classroom, and implications for learning. Finally, you should be able to articulate what theory is appropriate for what kind of learning design. This presentation will be completed on Photo Story. You will use the wiki to brainstorm ideas and to create a storyboard for your presentation. Be creative!

Students were placed in teams of four. These were their base groups. In their base teams, each student was assigned one of the four learning theories. Specifically, each team had one "expert" on each of the four theories. Students completed research on the assigned aspects and shared their findings with others researching the same topics. For example, all of the students researching *cognition* (see Figure 2) would come together as an expert group. Using a wiki outside of class, expert groups co-constructed the definition of their assigned topic as well as the roles of the learner and teacher, the envisioned design of the classroom, and the potential consequences for learning. When students met in class, expert groups met face to face to discuss and clarify their wiki definitions. This space assisted students in organizing, negotiating, and formulating their understanding of the topic. Once groups agreed upon the aspects of their topics, they returned to their base groups. Each person took turns teaching the others in their home team about their specific topic.

Following this jigsaw activity, the students worked together in their home team on creating a storyboard. Drawing on their wikis, they were asked to brainstorm ideas for a cohesive digital story that represented all four theories. Students were to find a unifying theme for their digital story, since in the end it was a single story. To guide their process, they completed a storyboard (Figure 3).

After finishing their storyboards, they uploaded them to their team wiki space to provide team members the opportunity to make adjustments collectively to the initial storyboard. It also allowed me to formatively assess the work and provide feedback when necessary. Next, the students began preparing their digital stories. They collected images to represent their ideas, as well as music to evoke emotions about the theories and their applications. Some students recorded voiceovers as background to production. The final stories were evaluated with a class-created rubric, which reflected the initial expectations of the project (Figure 6). All participants, peers and instructor, conducted assessments of

the stories. The final digital productions were a convergence of collaborative work with and through the technology (see sample videos: Video 1, Video 2, Video 3).
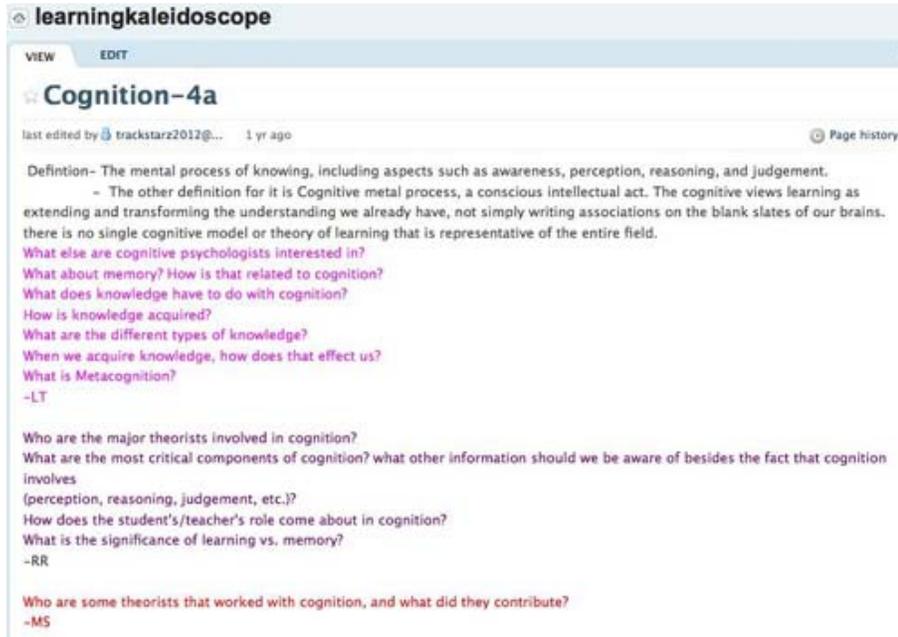
Figure 2. Student wiki about cognition.

Figure 3. Storyboard form.

1. **Four essential Learning Theory Rubric**

	2	5	7	10	
Collaboration from all participants	Every student did not participate on the wiki	One student did not equally participate	The majority of students equally participated	All students equally participated	——
Storyboard	Members of the group were unable to work together and write a storyboard	A storyboard was written, but lacked more than two of the expected components	A storyboard was written, but lacked one to two of the expected components	A storyboard was written with all of the expected components	——
Theory Defined	The definitions of the theories were not provided	The definition of the theories were stated, but not clear	The definitions of the theories were mostly clear	The definitions of the theories were well defined and examples were used to make them clear	——
What are some strategies that might be used for this theory	No strategies are provided	Strategies are provided, but not clear	Strategies are explained well.	Strategies are provides, explained in detail and connect to the role of the teacher, learning and learning environment	——
How are the theories helpful for teaching and learning	This question is not addressed	This question is addressed, but not connected to the larger picture	This question is addressed and is mostly clear, but still not connected to the bigger picture	This question is addressed, is perfectly clear and is connected to the bigger picture	——
Shows role of teacher, learner and design of classroom	Not present	Present but unclear	Present and clear, but not connected	Present clear and connected to the bigger picture	——
What are some drawbacks?	Not present	Present but unclear	Present and clear, but not connected	Present clear and connected to the bigger picture	——
What are the implications of learning?	Not present	Present but unclear	Present and clear, but not connected	Present clear and connected to the bigger picture	——
Connects to How People Learn	Not connected	Makes an effort to connect, but is not clear	Connects are there, but could be more explicit	Connections are present and explicit	
Effectively used images, sound and text	Effects not included	Effects partially included, but not used effectively	Effects used throughout, but not particularly effective	Effects used throughout and are effective for the presentation	——
				Total---->	——

Figure 4. Rubric.

Methodology

The data for this 2-week educational psychology project encompassed a collection of student-created artifacts. These included the wiki work, storyboards, student responses to the learning design, and their final digital stories. I drew on student self-reported experiences, in which they responded to open-ended questions on Moodle. Examples of these questions included the following:

- Describe your learning experience with the digital story?
- How would you describe the lessons' effectiveness in comparison to a lecture format?

- What role did the storyboards play to scaffold and organize your story?
- What role did the wiki play to scaffold and organize your group?
- Describe how you learned the content in this assignment.
- Describe your experience with the technology during this assignment.
- What changes would you suggest for the future?

These as well as a few additional questions focused on the student experience with this project and how the use of varied collaboration and construction activities aided in their understanding of the learning theories.

The data were examined using artifact analysis. Artifact analysis is an anthropological and archeological research technique, which provides insight into content created by participants. The method suggests an analysis of artifacts and interactions that are crafted in a setting and reflect a participant's meaning (as in Romero & Brem, 2004). In particular, this approach to analyzing artifacts includes who made it, what was the meaning, what was the medium, why was it made, who was the intended audience, who worked the creator, what was its use, and what did it tell us about how knowledge was constructed?

The analysis began with a read of the student responses to the learning design. These responses were initially coded using interpretive research (Erickson, 1986). I assigned descriptive codes to each response. I returned to these responses coding the data with broad themes. I again returned to the responses, identifying distinctions between the broad naming conventions, to more specific terms. The terms, for example, went from connecting to content to subcodes that provided a more detailed understanding of how and if students were connecting to the content.

These responses allowed me to consider the distillation of the experiences in relation to the mediating technologies of the learning design. These codes were then attributed to and tested out across different mediating artifacts. Namely, I applied what the students espoused to their interactions on the wiki, their expressions in the storyboards, and their application in the digital production. What materialized were emergent themes that highlighted student-generated affordances and constraints of the learning design.

In the following section are the emerging themes as well as an analysis of them. They are divided first under the core headings of Affordances and Constraints. Researchers attribute particular meaning to these terms in order to discuss aspects of the learning design and the use of technology to facilitate particular connections to learning. Briefly, the term *affordances* refers to the properties of things that suggest and allow that thing to be used (Norman 1988). *Constraints* reflects the limitations of possibilities or how designs inhibit certain things from occurring (Norman 1988). These terms assist in gaining insight into the properties of the activity that facilitate learning, as well as what in the design might be changed to improve the experience. All data used to support these themes are provided in raw form as written by the student.

Findings

Affordances

The intention of this learning design was to engage students in a constructivist model that utilized technology as an integral part of learning. In the design, the tools such as the wiki, the storyboard, and the digital stories played important roles in mediating knowledge building. Although the students did not use this language to express that this

was their experience, their reactions to the design illustrated the ways in which learning and technology came together for them. In particular, they spoke to their connections to the content through the various aspects of the design. Their positions come through a personal connection, the organizing tools, and the multimodal characteristics.

Personal connection. I define the category of personal connection as responses that connect to the individual in some capacity. This includes a feeling of personal investment, tapped creativity, and ownership in the project. When asked about how they perceived themselves as connected to the project, students responded in a variety of ways. The following excerpt begins to illustrate this connection. (Pseudonyms are used for all student quotations).

> The digital story was more effective than a traditional lecture for a couple reasons. 1. I am more interested in working on a computer and learning at the same time than I am in sitting in a classroom and getting lectured. 2. I was able to learn in a visual way which is my preferred way oflearning. I learn better when I see things visually and if I don't understand something, I had time to stop and look into it. In a lecture, if I didn't understand something, the lecture would keep going; if I stopped paying attention because something didn't make sense, I would lose the rest of the lecture. The other side of that was that I could move as fast as I wanted. Basically, I was able to learn at my own pace. 3. It was fun! No offense to any teachers out there, but lectures can get VERY boring sometimes. It was not the case for this specific class, but in many of my classes, where the professors just lecture, I have to try to keep myself awake because the class is so boring. I may have enjoyed this project more than others, though, because making movies, editing photos, graphic design, and things like that are things that I LOVE to do. (Pedro, questionnaire, 2008)

Pedro connected the learning to his interest in technology, his response to visual learning, and his engagement due to its interactivity. Other students echoed a feeling of personal and motivated investment in the project:

> I wanted to work on the project and I was very into it, especially because I like working with technology. Because of that, I was motivated and I found myself constantly wanting to work on it. If it was anything else, like a paper or even just a power point presentation, it would not have been as fun and it would not have been as great of a learning experience as it was. (Nancy, questionnaire, 2008)

The investment was also evident in the ways that students articulated their ability to unearth their creativity through the visual representations. One student specifically said that she needed to "think outside the box," while Tara said, "This forced me to be creative with representing and thinking about the content" (Questionnaire, 2008). The use of the term *force* suggests that in other learning experiences Tara does not feel that she needs to apply as much effort to making connections with the content.

Another student expressed a similar sentiment: "What I liked about the photo story project was mainly the way we were able to be innovative and creative without having specific guidelines to follow" (Jake, questionnaire, 2008). This student took the engagement one step further. In other learning experiences, Jake had not had the freedom to develop his own direction or employ his creativity toward developing his understanding of the topics.

Students felt a sense of responsibility for their own work: "I learned a significant amount while completing my photo story because I had to come up with photos that fit my particular topic. I was responsible for my part of the process" (Daren, questionnaire, 2008). Students insinuated that, rather than passively obtaining or listening to the information, students enjoyed their ability to construct meaning actively about their topics. Responsibility was not always to one's self, as noted in the following response:

> Well, you have always really pushed us to find the implications of the theories in the classroom but there is something to be said about having to present in front of a class. When there is a traditional lecture or assignment, students are not as intimate with the knowledge. In a traditional lecture, I count on you to fill in the gaps of things I didn't understand, but this project required I know the information, how to apply it, and then how to teach it. For this I needed to know the theories, and know them well. It held me to a new standard of accountability for my learning. It sure took me a lot longer than reading for a traditional lecture. It was nice to work in a group and feel more connected to the class, but at the same time there is something a little nerve-racking knowing you are counting on other people to do their part and keep up on their work. (Natale, questionnaire, 2008)

This statement highlights that not only did the students feel compelled to find images that reflect their own thoughts about the theories, but they also felt a responsibility to their team members.

These responses indicate that the design resonated with students, in that they felt it connected to their lives and the ways they liked to learn. In particular, placing students in the center of the design where they could construct digital artifacts tapped personal motivation. While motivation is important, it is only one part of the equation. In my experience, preservice (and often in-service teachers) cite motivation as a reason for using technology for learning. Yet, what they inevitably need to articulate is how the technology and learning intersect to support understanding. The theme of organizational tools sheds some light on how students are experiencing this aspect of the design.

Organizing tools. Organizing tools refers to the objects that assist in helping students structure gathered information into forms that help them question, visualize, and connect concepts they are reading. One example of such tools is cognitive organizers. In this design, the wiki, the storyboard, and the digital stories acted as organizing tools. In the following excerpts students expressed how the tools afford knowledge building and spatial organization. Two students talked about how the storyboard helped arrange conceptualizations into a format to assist their learning.

> [The storyboard] acted like an outline by giving me sort of a step-by-step process. I actually prefer them for organizing the content and thinking about if I'm really representing what I say I am. (Joe, questionnaire, 2008)

> ...storyboards and narration scripts without a doubt helped [me] stay organized throughout this project. Without it, I do not think I would be nearly as organized as I was. But overall, liked having the storyboard because I was able to organize all of the important information I had gathered. (Trish, questionnaire, 2008)

These students said that the mediating tools personally assisted and scaffolded their learning process. Each student seemed to prefer such tools in order to envision how to navigate the project. Although these comments were individually grounded, the

organizing tool was not just for the individual. Rather, students talked about it as a tool for solidifying the team effort and direction as well as helping them to stay on task.

> Once we [the group] started working together on the storyboard, everything began to fall into place. (Bella, questionnaire, 2008)

> We got to see pictures and relations to topics [wiki] and it acted a helpful way for our group to stay on the same page and direction. (Kim, questionnaire, 2008)

Bella and Kim suggested that the tools, both the storyboard and the wiki, were nodes around which conversations about the project occurred. The tools additionally were places for teams to negotiate and consider how the different pieces that each person brought to the table would fit into one connected story. As students went back and forth between content and tool, they talked around their ideas, figuring out what they knew and what they needed to understand better. Ultimately, their connection to the content was reinforced.

> Since [on the wiki] we have to form, write, and defend our own opinions and ideas from what we are learning, it helps all the info settles in. When you form an assignment in your own words and those of your members it makes you remember it better because it's coming from your own mind and those of your partners. Plus projects are overall less boring than just sitting there trying to retain material. (Jeff, questionnaire, 2008)

> ...learned most through process of creating photostory because when we summarize the info to put it together in a one minute story, you really develop an understand of the info begin displayed...(Sondra, questionnaire, 2008)

The use of the terms and phrases such as "better," "coming from your own mind," and "really develop an understanding" suggest specific realizations about how these students typically engage in learning. Although in this design students expected to be active and to draw on previous knowledge, their histories of learning in the classroom did not commonly include such characteristics. The idea that deeper understanding is a result of this engagement is evident in many comments that students made, for example,

> I felt confident enough to teach the theory to my group so that they could have a very good understanding of what my theory was all about. Even while we watched the other groups' digital stories, I kept learning. Even though the basic information for each theory was the same, each group presented it in a different way and each group emphasized different areas of the theories, so I was always learning. (Nancy, questionnaire, 2008)

Multiple examples replicate this sentiment. Implicit in these quotes is the underlying notion of how this learning design embedded unique opportunities for multiple modes of representing their ideas in media forms. Student reactions to organizing tools as a mediator of learning painted a picture for knowledge building. The activity of creating forms for how one is thinking alone and with a group suggested that students were more actively constructing knowledge. Although students did not explicitly describe the benefits of the tools for knowledge building, they implied that the negotiations and process around illuminating thinking and building on each other's work were important aspects for their learning.

Multimodal representations. Multimodality refers to the varied modes in which information and ideas might be represented or communicated. These modes come in the form of video, text, graphics, and audio, to name a few. In this learning design, students use graphics or spatial organizations of knowledge, as well as digital productions as ways of showing what they know and how they are coming to learn. Various excerpts from the data explicate the ways that students think about how visual forms impact their learning in various ways.

In the following quotations, Thomas and Kyle discussed how the media influence knowledge retention:

> Pictures in other groups stories that put lasting images in my head will help me with my teaching techniques. (Thomas, questionnaire, 2008)

> ...between music and images – I feel it was a lot easier to remember the information. (Kyle, questionnaire, 2008)

In both cases, students noted the power of images to support memory. Similar to experts in other categories, Kyle offered a comparison. Although this reference was not explicitly to text-based learning, one may assume that images are not readily a part of Kyle's learning experience.

The next quotation relates to the ways the images and creating the stories cultivated an interactive relationship between content and representation:

> The digital story was a way for me to learn and reinforce my knowledge of the subject matter. By doing research and working with others to complete a project, I learned a great deal about my group members topics as well as my own. Therefore although it was a great deal of work it was also a lot of fun and a unique learning experience. I feel that I have learned about the content in an efficient way. Doing this project forced me to research and formulate ideas about constructivism, which I knew nothing about previously. After the completion of the project I feel that I have learned about the different methods, and have formulated opinions about which ones I believe to be essential and which ones are not. (Kate, questionnaire, 2008)

Although the digital story was a part of this process, the excerpt points to the facts that all of the resources surrounding the completion of the multimodal text wentinto the success of it as a representation of content. Kate saw the interconnection of the parts of the learning design, but other students more specifically discussed the images themselves. I think that the images above all, really create a good understanding of the concepts and they clearly tell a story of whatever concept you are trying to explain. I learned so much more about our theories by having to choose images that we felt related to each theory. The images above all, really create a good understanding of the concepts and they clearly tell a story of whatever concept you are trying to explain. (Kathy, questionnaire, 2008)

> I learned a significant amount while completing my photo story because i had to come up with photos that fit my particular topic. (David, questionnaire, 2008)

For these students images were an effective way to show what they learned. These students both reported learning a great deal. Both stated that finding images to represent concepts was instrumental in learning content. These statements imply a silent dialog between image and content until a fit is established. Students needed to clarify their idea

of the theory in order to choose images that appropriately represented them. The reference in the quotation speaks to the fact that students were expected to express the theories in a compelling way that not only described them, but also applied to them.

> Multimodal elements were not only valuable to the learner, but also to the audience, for example, "I think that the creative use of music and pictures along with voice/words helped to impact and send the message to the audience more than what a traditional lecture would have done" (Don, questionnaire, 2008).

One interpretation of this quotation is that students believed these creations would provide more lasting impressions than would traditional lectures. In this way, students felt the media-rich digital stores were particularly powerful not only for themselves but also for audiences.

Students' responses seem to imply a significant value in the ability to intertwine components of sound, text, and images with understanding content. Just as they indicated that the organizing tools were helpful in supporting initial learning of the theories, students viewed digital media as a way to engage with and remember material more effectively.

Constraints

Although students suggested a number of positive aspects of the design, they also shared a number of challenges. Students initially felt confused about engaging in this new type of learning experience. They believed that the learning of new technologies increased the confusion. Finally, many students made comparisons to what was lost in the structure or lack thereof. I refer to these as "feelings of bewilderment," "elements of fear," and "comfort in tradition." Within these constraints are inherent comparisons to characteristics of traditional learning designs.

Feelings of bewilderment. I use the term *bewilderment* as a category to illustrate the initial confusion and ambiguity that students experienced in this learning design. The ill-structured nature of this particular assignment was naturally disconcerting for many of the students.

Students admitted to learning in ways that are more linear and text based. This common practice is undeniably pervasive in education, and students undoubtedly feel more comfortable in it.

> I was originally a little frustrated by the idea of this assignment. As an English Major, I am very text-oriented and had trouble limiting everything I read and trying to represent all of it with just a few pictures. However, thinking back on it, I think being able to explain all of cognition in a slide show is a good activity because, as a teacher, I need to be able to give simple, clear, instruction and information. I cannot always get all tied up with the details from the start. I have to be able to decide what is important and help my students figure out what is important out of a body of information. Learning to use the program itself is a good skill as more and more, learning because technology-oriented. (James, questionnaire, 2008)

James's initial reaction to this project indicates the limited access that students have to constructivist learning designs. What is interesting and compelling is that in one short

semester, he became open to them. Despite the initial frustration, James saw particular characteristics in this design that would be incredibly value for him in his teaching.

Other students associated with a mystification of another kind. What should I expect?

> …glad I had the opportunity to learn not only the content, but the new procedure how to make a photostory; The photostory assignment was a bit overwhelming at the beginning but once I figured it out, was not that difficult. (Tara, questionnaire, 2008)

In saying, "I figured it out," Tara suggested that she wanted more structure. Another student stated that this method was "more vague than just taking notes from a lecture assignment." In my experience of creating disruptive learning designs, students often and repeatedly long for structure. The idea of directed guidance and predetermined goals rigidly set by the teacher is one that is common in traditional learning engagements.

In designs such as the one outlined here, however, students must work to find their own purposes, form, and path. There were not solid expectations for the design, but the organic nature of knowledge building requires that students create their own direction based upon the nature of the group's emergent activity. In my experience, this feeling of disequilibrium about "uncertainty" and open-ended assignments comes from a lack of familiarity with them. If preservice teachers are to create highly interactive and engaging learning designs, they must find that they can succeed in them and not just talk effectively about them. The majority of the students in this study felt that they successfully achieved a comfort level with their initial ambiguity.

Elements of fear. A perhaps surprising theme was the students' pervasive fear of technology. Despite the fact that these students fell within the category of the Net Generation (Tapscott, 2002), the underlying anxiety about the amount of technology that would be used for learning was exceptional. For example, more than half of the students across both classes identified themselves as technology novices. In fact, many students reported hating or not being good at technology. Further, several students commented that they do not have access to technology at home.

Although this fear subsided considerably over time, it was an important consideration in my instructional design for preservice teachers. A great deal of media reporting supports the belief that this generation is technology savvy (Palfrey & Gasser, 2008; Ito et al., 2008). Yet such reports note that this generation does not wholly reflect the Net Generation definition (Palfrey & Gasser, 2008). My class did not fall within the more commonly accepted definition about this generation.

The following comments from students speaks to their novice status, as well as to how they thought about it over time:

> Not good with technology, get easily frustrated. This project helped me learn how to become comfortable with it. That happened as I learned from others in group. (Emanuel, questionnaire, 2008)

> I was slightly overwhelmed by the fact that we had to do so much on the computer: not technologically sound: Ten steps behind most of the world but PS [photostory] was quite easy to figure out. Might be because we had someone walk us through it – but feel I still could have figured it out. (Bill, questionnaire, 2008)

Students related to their limited technology expertise in different ways. Emanuel reached out to other team members in the group. Bill took an independent angle and, although he watched an introduction to the technologies, he felt he could have figured it out. Students not only felt more comfortable with it, they saw themselves confidently able to take a position that technology was not as bad as they previously thought.

> When you first showed us the photostory you had made, I thought "Yeah right, I'm not going to be able to make something that nice" but the technology was surprisingly user-friendly and we had no problem getting it to do what we needed it to do. (Tara, questionnaire, 2008)

> Not computer savvy – so wasn't thrilled when the assignment was given. after seeing the results and working on the project I realized it wasn't hard, but was enjoyable. (Sammy, questionnaire, 2008)

It is an important step when the students begin to see themselves as using technology for their own learning. One of the assumptions is that teachers must become comfortable with technology before they can use it with their students. The success experienced by these preservice teachers was not only about them becoming more comfortable with the technology. It was also about overcoming fears so that they could envision themselves using technology in their own teaching. The following excerpts illustrate that many students attain this vision:

> [This project] opened my eyes and helped me realize what kinds of things are possible with technology – that I wasn't aware of... (Emanuel, questionnaire, 2008)

> Thanks for showing us how to use the photostory and the wiki... already used both things in other classes and will definitely use them in my own classroom. (Tara, questionnaire, 2008)

> For future projects and activities I can use something new such as photostory and make it unique and interesting. (Leslie, questionnaire, 2008)

> Sometimes these students had a complete change of heart about teaching: "...have a hard time now seeing any other way of learning other than constructivism" (Sondra, questionnaire, 2008).

What began as a serious constraint for the learning design eventually materialized into an affordance for students' vision of teaching and learning with technology. While students initially lacked the sophisticated language to articulate exactly how they saw the ways technology supports learning, they began to form conceptualizations of its potential. Inhibiting this trajectory, however, were the resonances and comfort they found in traditional learning designs.

Comfort in tradition. It is not surprising that humans long for familiarity when faced with novel situations. These students encountered a design that was foreign to them. Not only were the varied technologies present, but the ways in which students were asked to move through a learning process was unique, as well. Not unexpectedly, preservice teachers repeatedly juxtaposed their moments of difficulty and frustration with their experiences in traditional delivery-style teaching and learning. Student comments revealed a feeling of loss, so to speak. For example, students discussed the amount of time required for learning to happen.

> Although I eventually learned about them, it probably would have been easier to learn it during a lecture. When everyone in my group tried to teach each other about the theories, it got a little confusing sometimes because we don't all explain everything as well as a professor would. (David, questionnaire, 2008)

> Passages such as this evidence the ongoing references they make to their perception that learning would be more efficient in lecture-style teaching. They suggest that the professor should provide the student with information. This design was unsettling; it tested the notion of who holds knowledge. In particular, Daniel stated, "A lecture done by a professor might have gone into much more detail" (Questionnaire, 2008).

Daniel assumed that finding this detail was not his responsibility. This comment is not surprising, but it is in direct conflict with the multitude of comments suggesting that deeper learning happened in this design that asked them to make their own connections. It might be the case that the professor can cover more and cover items more quickly. Yet students commented that in a traditional learning design, they did not really come to know the concepts in the same way and with the same rigor.

Related to this idea of professor as central to learning, a few students wanted more direction and handholding: "I would suggest that you introduce PhotoStory a little more in advance so students gain comfort" (Brian, questionnaire, 2008).

The use of the word comfort suggests a particular expectation as a learner. Part of the experience learning in constructivist models is to experience discomfort. This discomfort is not intended to be harmful, but rather to entice the student to come up with solutions and to engage more intimately with the content to uncover meaning.

This longing for comfort is a common desire. Yet, the most current research on how people learn indicates that learning is anything but neat and packaged. Learning is a complex practice and process (Darling-Hammond & Bransford, 2005). Multiple resources mediate learning; moreover, they mediate the construction of reality. As an educator whose charge is to ensure that preservice educators are prepared to engage their students actively in the complex and messy learning process, I am comfortable with helping my students to feel fine while stepping outside of tradition. The mediating tools that help scaffold learning and make thinking visible help provide a sense of stability in this disequilibrium.

Discussion

This paper began by articulating my intention to engage preservice teachers in a technology-mediated constructivist learning design. I investigated the ways in which students responded to this design and gained insight into how their experience compared to traditional experiences. At the crux of this design were the progressions of ideas and content and the representation of these ideas and content in the form of a digital story. The digital story itself was not in the forefront of the analysis. Rather, my examination of this learning design was focused on the affordances and constraints for students' knowledge building. This direction was intentional.

Summary of Findings

As noted in the onset of this paper, preservice educators need to engage in learning designs that are supported and facilitated with and through technology. Although the

final product was a digital story, the effective articulations of the learning theories within that story are highly influenced by the process taken to get there. The design pushed students into territories of learning with and through technology that they may never have experienced.

This learning experience brought about particular affordances and constraints for these students. In terms of affordances, students found that the design connected them personally to their learning. In addition, they saw the tools and the multimedia representations as integral to their active involvement in learning and their understanding of the concepts. During the process, students relied on social supports by seeking assistance on how to use the technology; they questioned each other about their verbal explanations on the Web, and they gave supporting arguments related to why they chose certain images.

Together the social supports and talk around the technological supports/scaffolds cohesively enhanced their learning experience. Although the experience seemed positive, students noted hesitations with this learning experience. Namely, they articulated their difficulties with open-ended assignments and their frustrations with technology.

Future Research

I cannot guarantee that these teachers will apply this same kind of learning design in their own classrooms. However, the learning design they participated in during this class immersed them in a design that bridged technology and learning to enhance knowledge building. The analysis of their reactions points to the fact that engaging in learning designs has demonstrated the benefits of making students the center of the learning process and responsible for their own learning. Ultimately, having experienced this learning design may give the preservice teachers a glimpse into how to facilitate these kinds of projects on their own. The students in these classes reflected on and began to think about their building knowledge around and for their digital representations. They will perhaps walk away with a vision of using similar designs with their own students someday.

This case study describes but one of many efforts made by professors in teacher education classes. The research outlined here is limited not only in that it spans two classes, but also that it relies largely on student reported data. As an ethnographer, the contextualized social activity is important to validate and triangulate findings. In relying heavily on self-reported data, one runs the risk of reducing the meaning of participation (Hammersley, 1990). Unfortunately, permission to videotape one's own teacher education classroom remains difficult to obtain.

My field notes and immersed interactions with my students could be one way to support student-reported data. For this work, however, it was my intention to have the students' voices tell the story. This conscious decision relates to my espoused philosophy of asking students to actively participate—as equally as possible—in the direction of their learning. Clearly, there is a need for more research of technology-mediated learning that is directly embedded within teacher education courses. At this juncture, continued studies with similar foci may help us ensure that preservice teachers can begin to imagine and employ the endless possibilities, possibilities that thoughtfully utilize technology to engage their students in increasingly meaningful learning experiences.

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