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Integrating cognitive apprenticeship methods in a Web-based educational technology course for P-12 teacher education

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Abstract

The purpose of this study is to investigate the integration of a cognitive apprenticeship model in a Web-based course. The subject of this study is an educational technology course for pre-service P-12 teacher education students. Specifically, this study presents student reports of how cognitive apprenticeship methods impacted student learning processes of (a) technology skills and (b) technology integration methods for teaching. The methodological framework for this qualitative investigation is an interpretive case study. Student reflections and teacher observations revealed that students found modeling, coaching, scaffolding, and exploration key to fostering skill knowledge, and they found the use of cognitive apprenticeship methods fostered an understanding of integrating technology for teaching and learning.
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1. Introduction

Within the past decade there has been a growing emphasis on integrating technology in P-12 education. The adoption and prevalence of the International Society for Technology in Education's (ISTE) standards has prompted P-12 teacher education programs to find innovative methods for fostering the effective use of technology for teaching and learning. Both Means (2000) and Dede (2000) argue that P-12 teachers should be able to use technology for specific content areas as well as personal productivity. Yet for programs attempting to provide distance education options to P-12 pre-service teacher education students, this poses a challenge. All too often, Web-based instruction is reduced to uninspiring content presented in a linear text-based format (Daviault & Coelho, 2003). Transposed lectures and extensive text-based content do little to model or enculturate pre-service teachers into the practice of integrating technology for their future teaching practice. The use of cognitive apprenticeship methods is an approach that holds relevance for both modeling the effective use of technology for pre-service P-12 teacher education students and as a method for the design of a Web-based learning environment. The notion of a cognitive apprenticeship was first introduced by Collins,

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Brown, and Newman (1989) when they advocated the use of the apprenticeship model for classroom instruction. Brown, Collins, and Duguid (1996) argue that cognitive apprenticeship methods attempt to "enculturate students into authentic practices through activity and social interaction in a way similar to that evident in craft apprenticeship". Within cognitive apprenticeship practices, learners are provided with modeling, scaffolding and coaching. Additionally, learners are provided with opportunities for exploration, articulation and reflection. Because cognitive apprenticeship methods foster the emergence of practical skills within an authentic setting, they may provide an effective means to enculturate pre-service P-12 teacher education students into the practice of integrating technology into their future teaching practices.

The purpose of this study is to investigate the impact of integration of a cognitive apprenticeship model in a Web-based course. Specifically, this study presents student reports of how cognitive apprenticeship methods impacted student learning processes of (a) technology skills and (b) technology integration methods for teaching. The goal of this study is to better understand the pragmatics, suitability, affordances, and constraints of integrating cognitive apprenticeship methods in a Web-based distance education course for teacher education.

2. Theoretical framework

The Web has had a resounding impact on education by both augmenting classroom practices and by affording educators new mediums for distance learning. During the past decade, postsecondary institutions have begun to offer and support various distance education initiatives at an ever increasing rate (Lewis, Snow, Farris, & Levin, 1999). A growing number of these distance education initiatives for undergraduate students are in the field of education (NCES, 2002). Of these initiatives, many are relying on the Web as a primary medium for delivery.

Concurrent with the emergence of distance education initiatives has been an epistemological shift in paradigms of learning from an objectivist perspective to a constructivist perspective of learning. Central to a constructivist theoretical perspective is the belief that knowledge is constructed, not transmitted, and that learners play an active role in the learning process (Duffy & Cunningham, 1996; Johnson & Johnson, 1996; Jonassen, 1999). Value is placed upon discourse opportunities, as the social nature of learning is not only acknowledged, but fostered (Jonassen, 1999; Winn, 2002). To foster the construction of knowledge, learners should have opportunities for exploration, interaction, and manipulation within the learning environment. This shift is impacting both traditional classroom practices and the design and execution of Web-based courses. For P-12 pre-service teacher education programs, this shift in theoretical foundations is posing an interesting challenge as instructional designers and educational technology educators and researchers strive to find methods to integrate educational technology from a constructivist perspective into distance and Web-based learning environments. The cognitive apprenticeship model is a design framework that holds relevance for both modeling the effective use of technology for pre-service P-12 teacher education students and as a method for the design of a Web-based learning environment.

According to Brown et al. (1996), prior to the emergence of formal schooling, the apprenticeship model was the most common means of educating learners in fields of practice. Apprentices learned their field by watching and assisting and master of a trade or practice. The apprenticeship process is an effective means for learning skills and trade, however, what Collins et al. (1989) proposed was to appropriate this process toward the application of cognitive knowledge. Because cognitive processes are primarily internal, finding methods for supporting *cognitive* apprenticeships is challenging in traditional classroom settings, but with the advent of Web-based learning environments, educators and instructional designers much re-think how design can foster cognition. Pre-service P-12 teacher education students are in the process of being educated within a field of practice. This field of practice involves both concrete skills and the adoption of *cognitive* processes. It is important to reinforce that notion, yet difficult to achieve in Web-based courses.

According to Collins et al. (1989), cognitive apprenticeship methods consist of several stages. Initially the student learns by watching the teacher model expert-level practices or strategies for learners. The internal processes that the teacher goes through must be articulated so students have access to the various internal strategies and heuristics that are used by the teacher (Collins, 2006). The teacher provides "scaffolds" which will support learners in their attempt to participate in expert practices or strategies. The term *scaffold* describes the temporary support framework provided to learners to support them in the process of extending competencies

(Bransford, Brown, & Cocking, 1999) and may take a variety of forms; however, the goal is to aide learners in adopting and developing strategies and heuristics for the field of practice. The teacher also *coaches* the students by offering guidance and feedback in the student's learning process. While students are adopting and learning new practices, they are strongly encouraged to *reflect* on their experiences and articulate their reasoning in using various strategies and practices. Learners are also provided with opportunities for exploration to enable them to apply some of the cognitive processes they have developed to new challenges. As students move towards independently applying what they have learned to new challenges, the teacher gradually reduces or fades the support (coaching). In many regards, cognitive apprenticeship methods may be particularly well-suited for a Web-based environment for educational technology because students must use educational technology to learn about educational technology.

3. Literature review

There have been several notable studies on the integration of technology and cognitive apprenticeship methods (Hendricks, 2001; Järvelä, 1995; Liu, 1998; Liu & Hsiao, 2002; Liu & Pedersen, 1998); however, relatively few explicitly investigate the use of cognitive apprenticeship methods in a Web-based environment for pre-service teacher education. Within a traditional classroom environment, Lowther and Clark (2002) found cognitive apprenticeship methods to be effective for fostering students understanding of using technology for teaching and learning.

Several research initiatives have been devoted to the development of technology tools and courseware that support cognitive apprenticeship methods. Pahl (2002) documented the development of online tools to support various types of scaffolding in undergraduate Web-based tutorials for database design. Although Pahl's design is consistent with cognitive apprenticeship methods and the setting is a Web-based environment, the focus of Pahl's inquiry is on developing automated scaffolding systems to reduce instructor-student interaction (2002). Along similar lines, Shabo, Guzdial, and Stasko (1997) investigated the development of Web-based courseware that integrated cognitive apprenticeship methods for learning computer graphics programming. Although the design of Shabo, Guzdial & Stasko's courseware did not explicitly focus on an automated system of scaffolding, they found students preferred highly structured supports to ill-structured supports. Additionally, within their courseware, the instructor plays a significant role in guidance and discussion. Stockhausen and Zimitat (2002) also developed a courseware to support the integration of cognitive apprenticeship methods. Stockhausen and Zimitat's courseware design provides a type of shell and navigational system in which individual content can be uploaded with discussion forums serving as a means for reflection and articulation. However, Stockhausen and Zimitat (2002) proposed interface design is merely that, an interface, and they readily acknowledge that an interface which is reflective of a theoretical perspective of learning does not guarantee that effective teaching strategies will be employed.

Pahl (2002), Shabo et al. (1997) and Stockhausen and Zimitat (2002) developed tools for fostering cognitive apprenticeship methods online. However, their research and development primarily focused on developing online systems which too varying degrees focused on automating instruction. This is clearly one way to approach the integration of cognitive apprenticeship methods in online learning, however, there are other avenues worthy of exploration and methods that focus less on automating instruction. Research has been conducted about the integration of cognitive apprenticeship methods in the design of Internet delivered online video case studies to support early literacy instruction for pre-service teachers (Schrader et al., 2003). Although the course was taught in a traditional classroom format, the distribution of the video case studies was online. Schrader's et al. found that video case studies of best practices helped initiate conversation and allowed learners multiple perspectives. In contrast, Saarenkunnas et al. (2000) investigated the integration of cognitive apprenticeship methods in the form of case-based conferencing for a Finnish and American collaborative course for pre-service teachers. Both Web-based asynchronous conferencing tools and video conferencing were used to support the collaborative course. Although the focus of Saarenkunnas et al. (2000) research is primarily on the Web-based discussions, the findings indicate that the integration of cognitive apprenticeship methods did enhance learning. Both Schrader et al. (2003) and Saarenkunnas et al. (2000) respective findings indicate the value and potential for integrating cognitive apprenticeship methods in Web-based instruction.

4. Methodology

The methodological framework for this qualitative investigation is an interpretive case study. According to Merriam (1998), the focus of an interpretive case study is to illustrate a phenomenon with the intent of analyzing and interpreting that phenomenon. The reason for choosing qualitative methodology for this study is not to provide a penultimate judgment about the integration of a cognitive apprenticeship model for the design of Web-based learning, but rather to better understand the relationship between instructional design, media, technology affordances, and constraint and to theorize about the impact this model might have on learners' perceptions about technology integration for their future teaching practice.

4.1. Setting and content

This setting for this investigation is a Web-based technology integration course entitled Integrating Technology and Education Practicum (I-TEP). I-TEP is a one credit semester course for students in a variety of teacher education licensure programs. Students must be of junior/senior standing. The focus of I-TEP is to model technology integration methods and strategies for pre-service P-12 teachers. Currently I-TEP consists of five thematic modules. Each module focuses on both instructional design and the integration of a technology tool to enhance learning. Modules include:

- learning theories (cognitive apprenticeship model);
- communication tools (email, electronic mailing lists, Web logs, instant messenger, and discussion groups);
- presentation tools (PowerPoint, graphic and audio software, and analogue and digital video);
- productivity tools (databases, spreadsheets, word processors, and graphical organizers);
- Web tools (Web resources and WebQuests).

In each thematic module, students are assigned readings and exemplars to view. Students are then required to respond to the readings and exemplars by reflecting in their Web log (blog). Next, students complete assignments in which they design lesson plans integrating a specific type of technology tool to enhance learning. Concurrently, students also produce educational media using the tool integrated in the lesson plans. For example, in the module focusing on productivity tools, I-TEP students would first read about the various uses of productivity tools for teaching, learning and personal productivity, then view exemplars of lesson plans along with corresponding media created with that productivity tool. They would then reflect upon their learning. Next, they would create a lesson plan integrating a productivity tool for learning and concurrently create an artifact with that productivity tool which would serve as a model for their (future) students. An example of this process might consist of an I-TEP student designing a lesson plan for 5th grade math in which 5th grade math students would use a spreadsheet for learning about graphing, averages and percentages using a popular candy (Skittles, Starburst or M&Ms). The I-TEP student would create a lesson plan and create a corresponding spreadsheet and graph which would serve as a model for students.

The goals for I-TEP are threefold. One goal is to foster student knowledge of how and when to integrate technology tools to enhance learning. The second goal is to help develop technology skills and confidence. The third goal is foster independence and risk-taking in learning new technology skills and integration models. As future teaching practitioners, I-TEP students will largely be responsible for fostering their own professional development in technology.

4.2. Cognitive apprenticeship methods

Within the I-TEP course, cognitive apprenticeship methods were manifested and integrated in the Web-based environment in several ways. To model expert practices of technology integration students were provided with a wide selection of exemplars of lesson plans. Additionally, students were presented with models and exemplars of a variety of educational media created using various technology tools. For example, in the productivity tool module, students were presented with exemplars of lesson plans along with artifacts (databases, spreadsheets, logical organizers, etc.) which corresponded to the exemplar lesson plans. These artifacts were designed to demonstrate expectations for learners.

Because I-TEP also focuses on developing technology skills, modeling was provided for fostering skill development in the form of both text-based instructions, and a series of digital videos and Flash animations called *Over My Shoulder* (OMS). The OMS videos and animations consisted of computer screen video captures of the instructor creating educational media and artifacts using various types of software while using think-aloud protocol to explain choices, methods and processes. The OMS media were not skill-based tutorials, but instead were attempts to model the thinking processes of the instructor while she created educational media using various technology tools. The OMS media purposely included some common mistakes and problems encountered while creating educational media which allowed the instructor to model strategies for trouble-shooting and problem-solving. For example, in the video demonstrating the process of creating a Web page with images, as the instructor uploads the Webpage, she encounters a problem because the images do not appear. She then goes through the process of trouble-shooting until the images appear in the online Webpage. By watching, listening, and even following along with the videos and animations, students observed the instructor modeling problem-solving and trouble-shooting strategies while creating educational media with various technology tools. The purpose of the OMS media was to foster technology skills, but more importantly to model methods and strategies for problem-solving and trouble-shooting while using various technology tools. The OMS materials were offered in many formats. They were created in three file formats (Audio Video Interleave (AVI), QuickTime, and Macromedia Flash file format (SWF)) to accommodate various Web browser plug-ins. Students had the availability of downloading the compressed OMS materials from the course Web site. Additionally, students could request a set of CDs, a DVD or VHS tapes of all of the OMS videos and animation.

According to Bransford et al. (1999) scaffolding is the temporary support framework provided to learners to support them in the process of extending competencies. Scaffolding may take many forms and serve many functions. Hannafin, Land, and Oliver (1999) categorized types of scaffolding by functions to include: conceptual, meta-cognitive, procedural and strategic. Conceptual scaffolding includes elements such as hints and recommendations. Meta-cognitive scaffolding provides learners with elements which would help students plan, organize, reflection and regulation during an activity (Brown, 1978). Procedural scaffolding includes support on how to perform a task, action, or process, whereas strategic scaffolding would include elements which would support learners in how to apply knowledge, principles, and experiences to various and new situations. Scaffolding was provided throughout the I-TEP learning environment in several ways. First, each of the four thematic modules was designed to build upon skills learned in previous modules. Students had the support of applying previous knowledge and skills to more difficulty challenges. Additionally, the level of instructional support and assistance was designed to scaffold learners in an attempt to foster independence and risk-taking for students. For example, during the first two modules, students' email requests for assistance were answered within a 2–10 h time span, however, as the course progressed, students were encouraged to seek other means for assistance. As each module progressed, the response time for email requests for assistance became longer. For the final module, students had a 15–24 h delay in response. The purpose of imposing this delay was because as future teachers, many of the students will need to find resources for problem-solving and trouble-shooting technology problems. Extending response times encouraged students, particularly those students who tended to procrastinate on assignments, to search the Web to find immediate answers to questions. This also built upon their skills for seeking and finding resources to aid in problem-solving and trouble-shooting skills.

Coaching plays a significant role within a cognitive apprenticeship environment. The teacher coaches students in the process of adopting expert practices and strategies by offering feedback, guidance and prompting when needed. Within the I-TEP Web-based environment, coaching was provided in different ways. First, email and instant messenger were used to answer initial questions and help learners get acclimated to the learning environment. A Web-log also provided not only a means for reflection, but also feedback. For example, students occasionally posted a question or an issue of concern and other students or the instructor might post responses to that question or issue in the student's Web-log. Because the course required students to create educational media, each student had access to their own individual online Web folder to which the instructor had full access. Students saved their work in this folder. As students created media and encountered problems, the instructor was able to look at the work-in-progress and prompt students and offer guidance.

Within a cognitive apprenticeship framework, learners should be encouraged to explore new ideas, viewpoints, and to form hypotheses and test them (Enkenberg, 2001), Within the I-TEP Web-based environment, this was supported by providing learners with a wide variety of models and exemplars of lesson plans and corresponding educational media. They were encouraged to look at resources critically and to reflect and articulate their ideas and thoughts to their Web-logs. This critical reflection was fostered in several ways. First, the material presented asked students to look at models and exemplars critically. Next, students engaged in reflective dialogue with each other and the instructor in the Web-logs and with the instructor via email. At the start of each module, learners were required to reflect upon their initial thoughts about the topic of the module and their opinions of the relevance of the tool-type for teaching and learning. After the module activities, learners followed up with a final reflection. Because the purpose of the course was to foster both technology integration planning and skill development, the reflections were designed to foster students' in becoming critical thinking about the use of educational technology as well as to become aware of their learning processes while developing technology skills.

4.3. Data collection

The data presented in this study were collected during the summer 2005 semester. Observation data were gathered from 42 students (3 graduate and 39 undergraduate students) from 11 different teacher education licensure programs. All of the students in this study gave consent for participating in the study. Additionally, 21 students participated in email interviews.

4.4. Data analysis

Data collection included observation of Web log postings, student work, student questionnaires, and email interactions and interviews. Additionally, prolonged engagement in the field, peer debriefing, members' check, negative case samples and an audit trail were part of the qualitative methodology (Glaser & Strauss, 1967; Lincoln & Guba, 1985). To support prolonged engagement the researcher was involved in observation through the duration of the course. Peer debriefing consisted of both formal reviews of data with one colleague in the field of technology for the duration of the study as well as several informal reviews with different colleagues in various fields of education throughout the study. Member checks were conducted informally during the process of data collection. Negative case analysis was conducted by reexamining the data to identify samples which displayed variation or contradicted the overall interpretations. Additionally, an audit trail was collected based on Lincoln and Guba 's (1985) six categories of information including: raw data, data reduction and analysis products, data reconstruction and synthesis products, process notes, and instrument development information (p. 319). Within this study, these sources included field notes, observation notes, student work, email interactions, blog postings, memos, and instruments.

This triangulation of multiple-data collection and methods was designed to support trustworthiness (Erickson, 1986), however, it should be noted that the interpretation of these data were still subjective (Fine, 1994; Peshkin, 1988). Although the author admits a bias towards technology, the author is aware that technology can be a filter in teaching and that the values perpetuated by computer technology may not be consistent with the researchers.

5. Findings

Two main components of cognitive apprenticeship methods are reflection and articulation. At the end of each module, students were asked to reflect upon their learning experiences, assess their performance, and describe how they gained new technology skills. Additionally, at the end of the course, they were asked to complete a summative reflection about whether cognitive apprenticeship methods had impacted their development of technology skills and their knowledge of technology integration. The following are both module and summative student reports of how cognitive apprenticeship methods impacted their development of technology skills and knowledge of technology integration.

5.1. Technology skills

At the end of each module, students were asked to post reflections via an online questionnaire about the assignments and their learning process during the module. Most students provided positive reflections about their experiences articulating various aspects of CA methods. The CA methods students responded to most frequently were modeling, coaching, and exploration.

5.1.1. Modeling

Although modeling was presented in many ways throughout the course, in a majority of student responses, students seemed to connect modeling explicitly with the OMS videos and animation. As these responses occurred, students were individually emailed to determine whether they understood that "modeling" in CA methods might take a variety of forms and indeed, that modeling was present in various formats in the I-TEP course. Forty (40) students responded that they understood this aspect, but found the modeling in OMS material to be most helpful for learning and improving technology skills.

> I gained new skills by referring to the Website for instructions. If I didn't know how to do something, I looked at several different kinds of instruction provided and watched the over-my-shoulder videos.
> I gained these new skills from the modeling through the videos.
> Created it on my own after watching a video of you creating one (sic).
> I had to watch the flash videos a couple of times.

5.1.2. Coaching

Only twelve (12) students commented about coaching in the module reflections, in the summative reflection and the final course evaluations, a majority of students noted the importance of timely assistance and coaching the occurred during the process of learning about technology integration, in fostering skills, and in preparing them to become more comfortable with technology.

> With the help of your "over my shoulder" tools, I felt comfortable... I felt your [professor's] guidance was very precise and easy to follow.
> The directions the professor provided really helped me in learning and building skills.
> When I found an obstacle, I asked for your [professor's] assistance.

5.1.3. Scaffolding

Scaffolding and exploration was a large component of the design of the course. Because I-TEP is a general education course, students from a wide variety of teacher licensure programs take the course. Students' experience with technology integration and technology skill levels vary from program to program and even sometimes from class to class, so one of the challenges of I-TEP is creating an environment which supports learners with a variety of technology experience and skills. Part of the challenge for the design of I-TEP is to provide an environment which supports low-levels of technology experience, yet with flexibility to support more experienced learners. The OMS videos provided the greatest level of scaffolding and were comprehensive, while the text-based materials provided the least scaffolding and required most skill experience. The OMS animations were mid-range.

Prior to each module, students were provided with a short questionnaire to assess their technology skills and integration knowledge. Students with less expertise in technology skills, who initially relied solely on text-based instructions initially encountered the most problems and asked for email assistance. Initially, the instructor answered questions via email and instant messenger; however, it was observed that students who used the OMS videos and animations seemed to encounter fewer problems. A large part of the videos and animation focused on trouble-shooting and problem-solving. Subsequently, students who requested assistance were referred to the OMS video and animations. Phrases such as "I tackle a similar problem in the ___ video (or animation)" were used. As a result, the requests for assistance were greatly reduced in a span of 2–3 days.

This process of guiding students towards appropriate levels and types of scaffolding was most apparent in email requests for assistance. As students' knowledge grew, their dependency on scaffolding receded. The final assignment for the course was creating and uploading a WebQuest. Materials to support the development of skills in creating a WebQuest webpage were provided in the form of text-based instructions and OMS videos and animations. This is the most difficult assignment because typically far fewer students have had previous experience with Web development tools. However, student reports and email requests for assistance were much lower than anticipated. Email interviews with students along with reflections revealed that many students began to seek and use other resources beyond those provided in the I-TEP course materials. When questioned about this, students responded that they felt confident to explore and learn. This trajectory toward independence and self-reliance was most apparent in reflections and correspondences with nine (9) students who began to find their own methods of learning rather than relying on material provided in the course.

> A lot of it was trial-and-error. I tried multiple things and if I didn't like it, I changed it.
>
> I used Web Wizard in Microsoft to teach myself what to do. Through exlporation (sic) and hands on practice.
>
> I experimented
>
> Trial and error. Pretty much all of it (sic).

One of the primary goals of the I-TEP is foster independence and risk-taking in learning new technology skills and integration models. As future teaching practitioners, I-TEP students will largely be responsible for fostering their own professional development in technology. Students were emailed and asked if the materials provided for the WebQuest assignment were sufficient. All replied that the materials were sufficient, however, nine students felt they had developed skills to try new resources or "figure it out" on their own. Although this was refreshing confirmation of meeting goals for instructions, with three (3) exceptions, the majority of these students were students who entered the course with higher level skills and more experience prior to taking the course.

5.2. Impact of CA on knowledge of technology integration

Most of the summative student reflections were positive about the use of CA methods in helping expose them to various methods for technology integration. Thirty-nine (39) students responded with positive comments.

> [Alan[1]] the use of cognitive apprenticeship methods in this course will provide me with concrete ways to implement technology into my classroom.
>
> [Kara] Now I have been given ideas and examples of how to use technology to help students think and develop their own conclusions.
>
> [Bethany] The methods used in this class have increased my desire to incorporate technology and have prepared me to do so better than I was before.

Although the majority of comments were positive, some trends were observed about how students perceived the value of using these methods. Fourteen (14) students specifically expressed appreciation about how the use of cognitive apprenticeship methods was more enjoyable or helpful than the lecture model.

> [Kelsey] Through this course I have learned a great deal about technology and its implementation into my field of music education. I have especially enjoyed the concepts involved in creating technology-inclusive lesson plans... I definitely enjoyed cognitive apprenticeship better than generic lecture and find it a successful teaching tool.
>
> [Andrew] My opinion about technology and teaching has changed throughout this course. I wasn't sure at first how it would fit in, but now I have a few resources to vary my instruction... The methods of cognitive apprenticeship has helped, because I learned by doing, not by lecture.

> [Anne] The cognitive apprenticeship methods were a good thing for me because I am a hands-on learner when it comes to my weaker areas. However, I need a lot of visual and auditory instructions with one-on-one time. This is simply the way I learn best.

What is significant about the trend in student responses is that they seemed to view cognitive apprenticeship methods as a valuable alternative to lecture-based classes. In follow-up email interviews thirteen of these students expressed the value in being an active participant in exploration and having a choice in selecting models relevant to their interest and future teaching careers.

One of the goals for any teacher preparation course is for students to transfer knowledge gained in teacher preparation classes to their future teaching practice. This was a challenge because in the Web-based I-TEP course, students were being exposed to new methods of teaching in a Web-based format, yet with the hope that they might transfer methods to a traditional classroom setting. Despite the fact that I-TEP was offered in a Web-based format, seventeen (17) students noted specifically the impact that cognitive apprenticeship methods would have on their future teaching practice in traditional environments.

> [Anne] I do not think I could stand in front of a class and teach without it [cognitive apprenticeship methods] now.
> [Lisa] Cognitive apprenticeship methods have allowed me to think of new ideas and techniques in which to teach my class.
> [Sara] I learn best with visuals and hands-on, so I am grateful that I have found a way to create this kind of environment for my classroom as well.
> [Marie] I think that understanding how and why to use technology gives me a better understanding to make better use of my classroom.

Eleven (11) students addressed how particular aspects of cognitive apprenticeship methods such as modeling and coaching fostered the development of their technology skills. Many of the students' reflections explicitly or implicitly highlighted aspects of modeling and coaching. Thirty-nine (39) students indicated that the use of coaching and modeling was helpful in their understanding of course materials as well as aided in their performance.

> [Kieran] Cognitive apprenticeship as I have experienced in this course is important, as it introduces many technology tools to students and coaches them to master the process.
> [Denise] ...the modeling in the videos helped me to figure out technical aspects.
> [Cindy] I learn best with visuals and hands-on, so I am grateful that you have found a way to create this kind of environment.

In email correspondences and instant messaging, students tended to clearly identify aspects of modeling in both the exemplars and with the OMS materials. During email interactions they often referenced a specific OMS video or animation.

> [Mindy] I followed you, but then I got a different screen than what you got (sic). [Referring to a video]
> [Cara] You said to click on the netdisk link and I did, but I got an error (sic). [Referring to a video]
> [Beth] Ok. I clicked on my folder like you did. Do I upload it here? (sic) [Referring to a video]
> [Mark] I clicked where you did, but then a differnt (sic) page showed up. [Referring to an animation]

What is interesting about many of the student email interaction is how the students described problems they encountered. The OMS material was designed to be purposely intimate in nature. The purpose for using think-aloud protocol was to give students an *inside* glimpse of the thought process involved in creating educational media. Several (13) of the student email messages were somewhat difficult to understand and required additional clarification because students seemed to have written the messages as though they were indeed peering over the instructors shoulder as the instructor performed various tasks. While some of the correspondences were humorous, they indicate a sense of personalized modeling.

While these students' correspondences indicated a sense of synchronous presence, the content of their messages indicated problems following the videos. Upon further investigation, eight students received error messages on two evenings due to network upgrades. Two other incidents of students receiving error messages was the result of student error.

6. Discussion

The purpose of this study was to investigate the integration of a cognitive apprenticeship model in a Web-based course. Specifically, this study presents student reports and teacher observations of how cognitive apprenticeship methods impacted student learning processes of (a) technology skills and (b) technology integration methods for teaching. The findings of this study reveal revealed that students found modeling, coaching and exploration key to fostering skill knowledge, and they found the use of cognitive apprenticeship methods fostered an understanding of integrating technology for teaching and learning.

With a few exceptions, student in I-TEP reflected positively about the impact cognitive apprenticeship methods had upon both their technology skill development and their knowledge of technology integration. In particular they noted elements of modeling, coaching and scaffolding as being important for fostering skill development. These findings are consistent with Lowther and Clark (2002) findings about the positive impact of using a cognitive apprenticeship model in preparing pre-service teacher to effectively plan for the use of technology for teaching and learning. It is important to note that Clark and Lowther's research setting was a traditional classroom-based environment whereas the setting for I-TEP was a Web-based environment. Nevertheless, according to student reflections, the use of models and exemplars, along with scaffolding, coaching and opportunities for reflection proved to effective methods for fostering technology integration for pre-service P-12 teacher education.

Initial observations of teacher–student interactions revealed that although students used all of the materials, the video and animations seemed to have the most impact in modeling techniques and skills. These findings are somewhat consistent with findings of Schrader et al. (2003). Whereas Schrader et al. found that the use of video case studies of best practices helped initiate conversation and allowed for multiple perspectives; observations and interactions with students in the I-TEP Web-based environment revealed that the use of video and animation allowed students to identify and articulate problem areas in regards to specific areas of skill development. Additionally, for many students it helped foster a sense of presence in a distributed learning environment.

During email interactions, many students referenced a specific OMS video or animation as though s/he was using the software while viewing the video or animation. Many students framed questions as though they were actually looking over a teacher's shoulder. Although little research in the use of cognitive apprenticeship methods with videos and animations such as those used in I-TEP has been conducted, Belland (1991), based on his application of his connoisseurship model with an audio-tutorial laboratory for college biology, argued that because of the intimate nature of audio-tutorials, the "tone, structure and ambiance" should be conversational in nature and not structured as though one were presenting a lecture to a large group of students (p. 26). In email messages, many students displayed interactions similar to those which would have occurred in a traditional classroom or lab settings. Students made reference to specific steps or processes which occurred in the videos and animations as though the instructor were present.

Most students indicated that various elements such as modeling and coaching were most helpful for their understanding of the course materials. Collins et al. (1989) stress the importance of the modeling and coaching as being the predominant methods of cognitive apprenticeship methods. Jonassen (1999) further analyzes the role of modeling by delineating between two types of modeling: behavioral and cognitive. Behavioral modeling focuses on psychomotor skills, whereas cognitive modeling involves internal processes. While use of OMS video and animations provided students with overt behavioral modeling for fostering skills, it also provided covert cognitive modeling of internal processes of decision-making and problem-solving along with rationales for choices and options. However, it would be interesting to allow students to choose from more than one instructor's internal processes.

Although modeling and coaching are important elements of cognitive apprenticeship methods, both scaffolding and exploration were observed to play a signification role in the I-TEP course. As students' skills developed, they relied less upon the video and animations and relied more upon text-based instructions and even their own exploration. While more research needs to be conducted, there was a notable trend of students moving from dependency on course materials toward more independence by using materials outside of the course. Although tenuous, these findings are not consistent with the findings of Shabo et al. (1997) about the role of scaffolding. In the Shabo et al. study, they found that student's preferred highly structured supports to ill-structured supports. For the most part, students in I-TEP tended to be able to identify their skill level and make suitable choices for their level of scaffolding. There are several possible explanations. First, prior to beginning each module, students were asked to reflect and report their skill levels. The act of reflection may have prompted more of a meta-cognitive awareness in students. Second, the highly structured supports took longer to view and they were not segmented into chunks dealing with specific skill areas. The length and lack of easily accessible relevant portions of the videos and animation may have prompted students to move from highly structured supports to those with less structure, but with more flexibility.

The span of the qualitative case study is by no means comprehensive, but rather is intended to examine both how tools and media can support or inhibit the integration of cognitive apprenticeship methods as well as the impact of integrating cognitive apprenticeship methods in a Web-based course for pre-service P-12 teacher education. Although the focus of this investigation is on the pedagogical implications, it also attempts to address media and methods. It is not, however, the purpose of this study to prescribe methods for integrating cognitive apprenticeship methods in Web-based learning environments, nor to designate how an online course should be structured. Rather, the findings of this study reveal the integration of cognitive apprenticeship methods had a positive impact and fostered P-12 teacher education students in their process of becoming educational technology practitioners. It should be noted that the applicability of these findings is context dependent. The students in this study had access to computer and Internet access which supported the use of video and animations, email, instant messenger tools, and other Web-based tools.

Although the findings of the qualitative case study reveals that the integration of cognitive apprenticeship methods had a positive impact on attitudes and performance, further research needs to be conducted. Certainly a quantitative study of attitudes and performance would yield findings from a different perspective. There is also a need for further research in outlining pedagogical methods for both behavioral and cognitive modeling. Within this study, although the role of scaffolding was revealing, an in-depth study of scaffolding supports would likely yield information about methods and techniques to apply effective scaffolding for learners in Web-based learning environments. Also, there is need for an in-depth study of coaching using a wider array of synchronous methods. Further detailed investigations of the integration of cognitive apprenticeship methods in Web-based learning environments may provide educators and instructional designers with a better understanding of how learners interact with tools, media and content.

7. Conclusion

The assertion of this investigation is that the cognitive apprenticeship model holds relevance for modeling the effective use of technology for pre-service P-12 teacher education students. It is the belief of this researcher that the integration of cognitive apprenticeship methods is necessary to enculturate pre-service and in-service P-12 teachers into the practice of integrating technology for teaching. However, for Web-based learning environments, integrating cognitive apprenticeship methods require educators and instructional designer to develop new strategies and techniques and to address who these elements impact learning.

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