SITUATED LEARNING WITH CASES: WEB-ENHANCED CASE-BASED REASONING IN TEACHER EDUCATION

by

HYEONJIN KIM

(Under the Direction of Michael J. Hannafin)

ABSTRACT

Cases are used to support situated learning in professional education because they contextualize learning and promote apprenticeship-like discussions between instructors and students. Recent work in case-based reasoning (CBR) reinforces important implications of situated learning, authentic activity as simulated experience by providing expert exemplary cases, and authentic tasks and activities. As novices engage CBR learning environments, they participate in social practices and develop context-based case knowledge, design strategies, and socially shared identities and beliefs.

This study examined how preservice teachers gain situated knowledge about teaching with technology by engaging the experiences of practicing teachers through Web-enhanced CBR. All students in the class were involved in Web-enhanced CBR projects and were provided expert teachers' exemplar case libraries and scaffolds via a Web-based, case-based doing tool (CBDT). Five preservice teachers, purposefully selected as participants, were interviewed throughout the semester, and artifacts of their reasoning were collected. Constant comparison techniques were used for data analysis.

Major findings indicated that participants' perceptions and understanding of computers' educational roles evolved from simple tools for productivity and motivation to diverse and advanced roles for learning concepts and developing thinking skills. They also developed critical concepts related to teaching with technology, including teachers' roles, students' characteristics, and pedagogy.

This study also examined how preservice teachers, as novices, in a semester-long Web-enhanced CBR learning environment, began to develop expert-like strategies, using CBR activities to understand both the culture and practices of seasoned teachers. Preservice teachers used automatizing, analyzing, articulating, and interweaving strategies during Web-enhanced CBR activities and considered Web-enhanced CBR as a catalyst and a framework to better understand the practicing teaching community. Web-enhanced CBR activities helped preservice teachers to learn the processes of, and develop the perspectives and knowledge situated in, the teaching with technology culture.

INDEX WORDS: case-based reasoning, situated learning, teaching with technology, teacher education, case study

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After meeting my major professor, Michael Hannafin, I said to my friend, “My advisor told me things today that are not in my dictionary. I am still trying to figure out what he meant.” When I said this to her several more times, she finally said, “Maybe your dictionary is pocket-size.” His advice has challenged me to think more, and more deeply, so that I could eventually understood what he meant. I have been nurtured that way. I sincerely thank my major professor, Michael Hannafin, for his priceless advice, mentoring, patience, and trust. I also thank my committee members, Janette Hill, Sharan Merriam, and Thomas Reeves, for their insightful and sincere support and advice. I have always thought myself to be very lucky to have such wonderful faculty members on my committee.

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PROLOGUE

Cases have been used in education for some time to address the shortcomings of traditional education methods (e.g., lecturing from a textbook) and to teach context-specific and complex knowledge, as well as problem-solving skills (Lundeberg, 1999; Masoner, 1983; Merseth, 1996; Williams, 1992). As situated cognition and learning perspectives provide significant implications for education, emphasizing the importance of knowing, acting, and culture (Putnam & Borko, 2000), the perspectives revisit the educational potential of case methods. Case methods allow situated learning in higher education by contextualizing case narratives and facilitating case discussions between instructors and students (Cater, 1989; Putnam & Borko, 2000; Shulman, 1992).

Case methods, however, require new approaches in order to satisfy the critical assumptions of situated learning perspectives; learning and acting are inseparable, and experience is provided through authentic activity (Brown, Collins, & Duguid, 1989). Knowledge both evolves continuously in new situations and results from interactions during activity. To this end, this dissertation study explored the theoretical grounding, pedagogical approaches, and research related to situated learning with cases in preservice teacher education.

Case-based reasoning (CBR) provides the important theoretical grounding and concrete methodology for situated learning with cases. As CBR assumes that humans store and retrieve knowledge in the form of cases and reason based on the cases, CBR learning environments revisit the role of cases and the pedagogical methods of using cases with the affordance of computers (Kolodner, Owensby, & Guzdial, 2004; Schank, & Cleary, 1995; Schank, Berman, & Macpherson, 1999). Cases deliver not only contexts, but also experts' knowledge and insights. Learners conduct authentic tasks by using the experts' exemplary cases. As these educational models share a commonality with apprenticeship in situated learning (Riesbeck, 1996; Schank 1993/1994), learners in CBR learning environments may indicate learning processes and results similarly in apprenticeship environments. Teacher learning during CBR is relatively new and, from the situated perspective, rare. This dissertation study examined preservice teachers' learning and knowledge development via CBR learning environments from the situated learning perspective.

The context is important in this study because situated learning and CBR emphasize learning and knowledge situated in the community of a particular context. The shared characteristics of knowledge, beliefs, and skills in the context are used as a theoretical framework and provide the background literature that aids in understanding novices' learning and knowledge. Accordingly, the specific context in this study is a preservice teacher education course for teaching with technology. Preservice education research and practice have become increasingly significant in guiding teaching with technology. Many researchers and educators agree that teacher education programs need to promote meaningful technology integration in the future teacher workforce, and not simply promote mastery of isolated computer skills and applications (Beyerbach, Walsh, & Vannatta, 2001; Brownell, 1997; Gibson & Hart, 1997). Accordingly, Web-based cases featuring exemplary teachers' implementations of computer-based or -enhanced lessons (e.g., see Ertmer et al., 2003; Grabe & Grabe, 2001; Wang, Moore, Wedman, & Shyu, 2003) have been developed.

In this dissertation study, design and research related to situated learning with cases contribute to the community of teachers who use technology.

Chapter Overview

The overarching purpose of this dissertation was to present and study an integrative design and learning model of technology-enhanced CBR learning environments for professional education. To this end, this dissertation study presents a series of related journal-ready manuscripts in each chapter, featuring a theoretical framework, grounded design, and two research studies.

The first chapter, *Situated Learning With Cases: A Model for Teacher Preparation*, is the theoretical framework paper and explains the characteristics of situated learning and knowledge resulting from case-based situated learning. To this end, the chapter begins by presenting new roles of cases and authentic activity in teacher education. The major focus of the chapter is the development of a theoretical framework for situated learning and knowledge that draws from situated learning and CBR literature. The target audience was the community for preservice teacher education and case-based learning environments.

The second chapter, *Grounded Design and Web-enhanced Case-based Reasoning: Theory, Assumptions, and Practice*, presents the theoretical framework and design practice for the CBR learning environment. This chapter introduces the specific design principles and implications for Web-enhanced case-based doing (CBD) environments featuring grounded design principles. The target audience was researchers and practitioners who are interested in technology-enhanced, CBR, and constructivist learning environments.

The third chapter, *Learning to Teach With Technology: Developing Situated Knowledge via Web-enhanced, Case-based Reasoning*, presents a research study exploring how preservice teachers gain situated knowledge about teaching with technology by engaging the experiences of practicing teachers through Web-enhanced, case-based reasoning. Changes in preservice teachers' perceptions and understanding of educational roles of computers and critical concepts were documented over the course of a semester. The target audience was the community for preservice teacher education, especially for teaching with technology, researchers, and practitioners who were all interested in situated learning.

The last chapter, *Web-enhanced, Case-based Reasoning in Preservice Teacher Education: A Case Study*, presents a research study exploring preservice teachers' learning processes in and interactions with the Web-enhanced CBR learning environment. To this end, preservice teachers' strategies and perceptions for CBR activities were documented during a semester-long course. The target audience was the community for technology-enhanced, case-based approaches in teacher and professional education, researchers, and practitioners who are all generally interested in technology-enhanced or -based learning environments.

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CHAPTER 1

SITUATED LEARNING WITH CASES:

A MODEL FOR TEACHER PREPARATION[1]

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Abstract

The emphasis on contextualized, active learning in teacher education has heightened interest in technology-enhanced case methods. Situated cognition theory has important implications for technology-enhanced case methods, leading to new roles of cases and authentic activity. Through situated learning with cases, preservice teachers can gain context-based and concept-grounded case knowledge, design strategies, and socially shared identities and beliefs. In this paper, we present situated cognition as an epistemological perspective for case-based approaches in preservice teacher education and propose a conceptual framework for preservice teachers' situated learning in case-based environments.

Cases have been used for some time to address the shortcomings of traditional teacher education methods (e.g., lecturing from a textbook) and to represent teaching as a context-specific undertaking rather than a unitary and strictly procedural enterprise (Merseth, 1996; Schulman, 1992). In teacher education, conventional case methods typically include printed case materials and teacher-led, Socratic discussion designed to orient preservice teachers to the practices of seasoned, veteran teachers. With the emergence of computer technology and constructivism, new ways of using cases have arisen. For example, anchored video cases support technology-enhanced apprenticeships by establishing authentic contexts and tasks for situated learning (Cognition and Technology Group at Vanderbilt, 1990; 1993). The emphasis on contextual and active learning for teacher education has also stimulated interest in technology-enhanced case methods, where cases help to contextualize the learning of inexperienced, preservice teachers in authentic classroom dilemmas (e.g., Derry & The STEP Team, in press; Kinzer & Risko, 1998; Merseth & Lacey, 1993; Putnam & Borko, 2000; Schrader et al., 2003). Learning involves enculturation, reflecting realistic events and problems, experts' tacit knowledge, and the culture of the community rather than the accumulation of decontextualized, abstract knowledge and skills (Brown, Collins, & Duguid, 1989; Greeno & The Middle School Mathematics Through Applications Project Group, 1998; Lave & Wenger, 1991).

While case-based learning environments are designed to situate learning, few attempts have been made to ground such approaches theoretically or to define the elements of case-based learning environments appropriate to situated preservice teacher education. The purpose of this paper is to present a situated cognition framework for, and to propose a framework appropriate to, the design of case-based preservice teacher education.

Situated Cognition and Teacher Education

Researchers (e.g., Brown et al., 1989; Clancey, 1997) have characterized situated cognition as an epistemological perspective for explaining cognition and learning. Epistemologically, situated cognition emerged from various theories, such as activity theory, the sociocultural theory of Vygotsky, Dewey's pragmatism, and ecological psychology, and has been influenced by different perspectives, such as psychology, sociology, and anthropology (Chaiklin & Lave, 1993; Kirshner & Whitson, 1997; Wilson & Myers, 2000). These theories share core assumptions about human learning and cognition—knowledge is situated in context; activities, concepts, and culture are integrally connected within the broader system; and learning involves all three (Brown et al., 1989; Lave & Wenger, 1991). Situated cognition proponents view learning as linked to experience and enculturation, where novices engage authentic activities in authentic contexts.

In teacher education, situated learning occurs in the real world in the form of mentor-apprentice relationships among expert, peer, and novice teachers. Ideally, apprenticeships afford opportunities to observe and engage the practices of experts from whom novice teachers learn (Sykes & Bird, 1992). Preservice teachers, however, cannot always have access to or opportunities to engage with, the practices of expert teachers. K-12 classrooms that exemplify ideal teaching environments, provide access to expert teacher-mentors, and provide for legitimate participation appropriate to the readiness of preservice teachers are rare (Putnam & Borko, 2000).

For example, national initiatives, such as the Preparing Tomorrow's Teachers to Use Technology (PT3) program, have underscored the discrepancy between idealized and everyday teacher education practices. Technology is central to many teacher education and reform initiatives (Chisholm & Wetzel, 1997; Cuban, Kirkpatrick, & Peck, 2001), but placement opportunities where effective technology integration practices are employed are distressingly rare. It is difficult for teacher education programs to find sufficient numbers of expert teachers who use technology, so technology courses are typically taught as discrete, decontextualized skill development across offerings focusing on mastery of various applications (e.g., presentation software, databases, Web searching). Subsequently, preservice teachers are expected to transfer technology skills into an innovative, contextually-sensitive approach having neither practiced, observed, nor participated in such approaches previously—a widely criticized, yet dominant approach to preparing new teachers to integrate technology into their classrooms (Gillingham & Topper, 1999; Office of Technology Assessment (OTA), 1995; Willis, Thompson, & Sadera, 1999).

Cases, supplied and validated by expert teachers, may better situate such experiences in university classrooms. Related approaches have long been used in education and typically include printed or video scenarios and group or teacher-led discussion. Technology-enhanced situated learning (e.g., technology-enhanced cognitive apprenticeship) may help to both extend and deepen these approaches (Collins, Brown, & Newman, 1989). Web-based case tools, for example, can provide additional educational benefits such as multiple expert models and teacher or student collaboration, extending the traditional field experience (Baker, 2000; Putnam & Borko, 2000).

Situated Learning With Cases

Figure 1.1 illustrates the teacher education model of situated learning with cases. In the following sections, we describe how situated cognition and cases inform each other and influence the emergence of case methods for situated learning.

Role of Cases

Cases include various formats, foci, characteristics, and roles. Shulman (1992) explains some common characteristics of narratives:

> A case has a narrative, a story, a set of events that unfolds over time in a particular place…these teaching narratives have certain shared characteristics.
>
> ● Narratives have a plot—a beginning, middle, and end. They may well include a dramatic tension that must be relieved in some fashion.
>
> ● Narratives are particular and specific. They are not statements of what generally or for the most part is or has been.
>
> ● Narratives place events in a frame of time and place. They are, quite literally, local—that is, located or situated.
>
> ● Narratives of action or inquiry reveal the working of human hands, minds, motives, conceptions, needs, misconceptions, frustrations, jealousies, faults. Human agency and intention are central to those accounts.
>
> ● Narratives reflect the social and cultural contexts within which the events occur (p.21).

Based on these characteristics, cases can be classified as having two primary roles: to provide context and to represent knowledge.

Case as context. Many educators use cases to convey contextual information depicting real-world complexity, including both problems and exemplary models. The contextual nature of cases is a commonly cited reason for their effectiveness and applicability in constructivist environments (Jonassen, Dyer, Peters, Robinson, Harvey, King, & Loughner, 1997). From the situated cognition view, the context from cases presents rich information, including people, shared culture, understanding, design artifacts, and motivation (Young, 1993). Cases, therefore, allow preservice teachers to deeply understand theories in real teaching situations and enable them to experience classroom situations as a practicing teacher.

Case as knowledge. Cases, ranging from dilemmas to exemplary cases, also embody experts' knowledge and critical aspects of the domain under study in both explicit and implicit ways (McLellan, 1996). For example, researchers examining case-based reasoning and narrative as a form of knowing suggest that people store knowledge in the form of cases, that is, narratives (Kolodner, 1993; Schank, 1999). Likewise, situated cognition advocates suggest that a story represents an assemblage of situated knowledge (Lave & Wenger, 1991). Experts' stories embody the experts' cultures, insights, and experiences (Brown et al., 1989; Shulman, 1992) because they reflect their problem-solving strategies. When provided in the format of both real classroom events and experts' stories, cases embody both authentic situations as well as domain knowledge.

These perspectives provide two instructional implications to preservice teacher education. First, when preservice teachers watch cases and use the ideas from the teachers' cases, they can gain the "stolen knowledge" (Brown & Duguid, 1996, p. 47). Preservice teachers, therefore, learn a sense of who-to-be as well as what-about (Brown & Duguid, 2000). Second, cases as knowledge also allow preservice teachers to have their own cases as a package of situated knowledge and to have sense of how to use knowledge in a natural way.

For situated learning with cases, cases have the role of both contexts and experts' knowledge. Through these roles of cases, preservice teachers may have an opportunity to deeply understand theories in various situations and also to build a set of vicarious experiences to solve classroom problems.

Role of Activities

Teacher-led and group discussion are among the most common case processing activities (Merseth, 1996). Particularly, for situated learning with cases, these methods should emphasize realistic authentic activities beyond basic analysis; authentic activity is central to gaining situated knowledge and entering the culture of the community (Brown et al., 1989; Lave & Wenger, 1991). Through authentic activity, preservice teachers may gain knowledge and meaning-making akin to that of experienced teachers through their repeated practices.

Authentic activity, the "ordinary practices" of a particular community, extends beyond simple hands-on activities in decontextualized tasks (CTGV, 1990). Brown, Collins, and Duguid (1989) proposed the term "cognitive apprenticeship" as a situated learning model for classroom situations where a teacher, a student, and peers work together through mentoring, collaboration, reflection, and multiple practices modified by a craft apprenticeship. Likewise, during situated learning with cases, preservice teachers apprentice under both the virtual mentor teachers represented in cases and university faculty. In particular, the conversation between "old-timers and newcomers" is essential because sharing stories extends community lore, experiences, and practices (Lave & Wenger, 1991, p.29), helping to create the conversations between mentors and novices (Carter, 1989). Through case discussion, preservice teachers more deeply analyze the cases and steal old timers' knowledge (Brown & Duguid, 1996).

Case discussion also helps to guide the ensuing activities, which enable preservice teachers to experience realistic, authentic tasks. In situated learning, authentic tasks are ill-defined and problem-solving in nature, rather than simplified and easily answered (Brown et al., 1989; CTGV, 1990; Young, 1993). As in the real world, they contain a variety of information and complex goals, perspectives, values, and cultures. For teacher education use, it is important to identify the ordinary practices of expert teachers and to determine which are sufficiently authentic and effective within post-secondary classrooms. For teaching with technology, expert teachers often develop clear lesson plans focusing on student-centered, authentic tasks (OTA, 1995) and complex pedagogical decisions (Pierson, 2001) prior to implementing technology-enhanced lessons (Chisholm & Wetzel, 1997; Pierson, 2001; Russell et al., 2003). In their case study, Gibson and Hart (1997) indicated that elementary teachers' preparation improved implementation only when they previously used technology in their classroom. Likewise, many researchers and educators suggest that preservice teacher programs need to move beyond functional views of technology (e.g., learning how to use Internet or email) and address why or when to use technology in the classroom (Beyerbach, Walsh, & Vannatta, 2001; Gillingham & Topper, 1999; Hargrave & Hsu, 2000). By experiencing these activities under the tutelage of experts' and classroom cases, preservice teachers transition to the culture of teaching and develop situated knowledge *to be used*.

Anchored instruction (CTGV, 1990; 1993; 1997), for example, involves the use of broad and complex problem cases presented in the form of video vignettes, called *macrocontexts.* Broad problem cases allow students to engage authentic tasks. The design principles include embedding ill-defined problems and blending contextually relevant and irrelevant information in broad problem contexts, providing real world complexity and multiple perspectives from experts such as mathematicians, scientists, and historians who interpret the same situations. The learning goal of anchored instruction is to help students both identify and solve problems. Students are asked to develop their own perceptions and understandings rather than those "given" by the expert. The teacher's role is largely to facilitate and guide student inquiry, rather than to explicitly teach or "tell" students what problems need to be addressed or how to solve the problems generated. Technology enables multiple representations, rapid access to specific parts of the video vignette and to various information, and the compression of time in order to both represent and examine a case or problem in greater depth than is possible in real-time.

Another example, the Web-enhanced case-based reasoning (CBR) learning environment, engages preservice teachers in simulated, authentic activities related to teaching with technology (Kim, Hannafin, & Thomas, 2004). Authentic tasks consist of designing technology-enhanced lessons, developing instructional materials using technology, and implementing the developed lessons. Preservice teachers engage their assignments in partnership with a virtual exemplary teachers' case and the instructor. To document expert teachers' cases, a Web-based tool was developed to organize the expert teacher's experience into a case library and link it to related, online cases. Cases include interviews with expert teachers and information about their experiences (stories), which are keyed to course objectives and projects. In addition, questions are provided to guide preservice teachers as they analyze, plan, act, and reflect upon the cases. Through the guiding procedures, preservice teachers engage authentic tasks as professional teachers do. The guiding questions consist of the critical concepts for teaching with technology (e.g., potential of the software program, reasons for using technology, learning goals). Microteaching is followed by individual course projects so that students can practice implementation in one of their lessons. Collaboration is provided through whole class discussion for case analysis, feedback from peers on their scenarios, lesson plans, and artifacts. Through this environment, preservice teachers observe and use expert teachers' models as they join the community and gain situated knowledge about teaching with technology.

A Case-based Model for Situating Preservice Learning

Several researchers report that learning from cases yields both conceptual knowledge and procedural knowledge, including contextualized understanding of theories, multiple perspectives, problem-solving skills, and reflection skills (Harrington, 1995; Harrington & Garrison, 1992; Lundeberg, 1999; Merseth, 1996; Tippins, Koballa, & Payne, 2002). Pedagogical content knowledge, an important form of teacher knowledge, has also been enhanced through case methods (Barnett, 1991). Social constructivists who examine teacher learning characterize case discussions as tools for improving social discourse and strengthening learning communities (Harrington & Garrison, 1992; Levin, 1995; Merseth, 1996). These promising findings have been generated mostly using dilemma-based cases, case discussions, and written case analysis.

When cases also embody context and expert knowledge in authentic activity, evidence further supports the value of situating cases. From the situated cognition perspective, knowledge is “always under construction,” continually evolving in new situations and resulting from interaction during real-world activities (Brown et al., 1989, p.32). Through activity, novices hone their perspectives and develop identities as members of the community (Lave & Wenger, 1991). By embodying context and expert knowledge in cases, preservice teachers enter the culture of a domain, experience the community’s ordinary practices, refine their belief systems, and learn the conceptual tools of the community (Brown et al., 1989). Greeno et al. (1998) explain the goals of learning from the situated learning perspective:

> We need to organize learning environments and activities that include opportunities for acquiring basic skills, knowledge, and conceptual understanding, not as isolated dimensions of intellectual activity, but as contributions to students’ development of strong identities as individual learners and as more effective participants in the meaningful social practices of their learning communities in school and elsewhere in their lives. (p. 17)

Situated perspectives emphasize participation in everyday practices in order to construct both socially shared meaning of concepts and identities and socially shared skills. Cognitive apprenticeships, for example, support students as they gain situated knowledge through legitimate participation, including domain knowledge, heuristic strategies, control strategies, and learning strategies (Collins et al., 1989). It is important, therefore, that cases situate learning in authentic, everyday teaching circumstances and practices and that the experience, wisdom, and insight of expert practitioners be available to preservice teachers as they engage cases.

We examine the nature of situated knowledge associated with situated, case-based teacher learning along three dimensions. The relationship among conceptual case knowledge, strategic knowledge, and identities and beliefs is depicted in Figure 1.2.

The nature of situated knowledge emphasizes the understanding of the "whole person" (Lave & Wenger, 1991, p. 33). To this end, situated knowledge involves three dimensions, representing comprehensive knowledge and skills by interacting with and influencing one another. For example, as novices experience activities, they gain an understanding of the concepts involved in particular situations (conceptual case knowledge). They also learn strategies regarding how to use those concepts in future tasks (strategic knowledge). Because those concepts and strategies also reflect the values and beliefs of a particular community, novices gradually construct socially shared identities and beliefs by negotiating community beliefs with their own. Table 1.1 summarizes the characteristics of each dimension.

Conceptual Case Knowledge

Conceptual case knowledge refers to declarative, conceptual knowledge. From situated cognition perspective, knowledge is considered to be "context-dependent" (Brown et al., 1989, p. 32). Brown et al. compared the activities of JPFs (just plain folks), practitioners, and students. Just plain folks (JPFs) reason with causal stories, act on situations, resolve emergent problems and dilemmas, negotiate meaning, and socially construct understanding. Likewise, practitioners reason with casual models, act on conceptual situations, resolve ill-defined problems, and produce negotiable meaning and socially constructed understanding. Students, in contrast, tend to reason with laws, act on symbols, resolve well-defined problems, and produce fixed meaning and immutable concepts. That is, unlike everyday people and practitioners, students tend to learn and reason mechanistically as they attempt to acquire the knowledge and lore of a community of practice. Lave and Wenger (1991) extend this perspective in describing expert behavior, noting that their situated knowledge is often represented in stories that embody their experiences, not in the specific knowledge and skill components enacted during practice. Furthermore, they argue that "the world carries its own structure so that specificity always implies generality" (Lave & Wenger, 1991, p. 34). Stated differently, experts' stories essentially represent the knowledge structure of a domain; conceptual knowledge, in effect, may be best represented in the form of cases.

Conceptual case knowledge, like declarative knowledge, relates to "knowing what," such as concepts and facts (Bruning, Schraw, & Ronning, 1999). According to Collins et al. (1989), "domain knowledge includes the conceptual and factual knowledge and procedures explicitly identified with a particular subject matter…generally explicated in school textbooks, class lectures, and demonstrations" (p. 477). They further assert that domain knowledge is insufficient without realistic contexts and expert practices. When domain knowledge becomes situated, its nature and meaning become shaped by, and better understood within, the associated community.

Conceptual case knowledge can be elaborated through "indexicalized representations" (Brown et al., 1989, p. 37). Indexicalized representations include knowledge structures that are interwoven into various situations, resulting from and shaped by perceptions from activity changes. Experts' conceptual case knowledge is shared in narratives (i.e., stories) and stored as differentiated situations with plots. Conceptual case knowledge, therefore, shares the narrative nature of knowing (Bruner, 1986; Carter, 1990; Schank, 1999), but also reflects the conditional nature and situativity of that understanding.

As novices gain experience, their indexicalized representations become richer, eventually enabling them to build collections of their own case knowledge, that is, a personal "case library" (Kolodner, 1993, p. 141). Metaphorically speaking, a case library organizes and indexes conceptual case knowledge according to key concepts, values, and practices of a community. As preservice teachers gain experience and refine their case libraries, they gain increasingly contextualized and conditional understanding about the knowledge and practices of teaching (Schank, 1999). Accordingly, it is important to identify the knowledge structure of the expert teachers' conceptual case knowledge in order to embody them appropriately within cases.

Expert teachers' conceptual case knowledge for teaching with technology, for example, has been documented in several reports (e.g., Becker, 1994; Becker & Ravitz, 1999; Ertmer, Ross, & Gopalakrishnan, 2000; Norton, McRobbie, & Cooper, 2000;

Windschitl & Sahl, 2002), casebooks (e.g., Sandholtz, Ringstaff, & Dwyer, 1997), Web-based cases (e.g., http://www.intime.uni.edu/), and formal documents (e.g., National Educational Technology: Standards for Teachers by International Society for Technology in Education). In many regards, the characteristics of conceptual case knowledge are akin to, but extend beyond, teacher knowledge in given subject areas.

While teacher knowledge typically focuses on knowledge of students, curriculum, content, and pedagogy (Leinhardt & Greeno, 1986; Shulman, 1986), Fisher (1997) noted that experienced teachers identified the competencies of teaching with technology, including basic technology skills and their integration into curriculum and instructional strategies. For example, an expert teacher may use flow-charting software, such as *Inspiration*, while teaching 10th graders concept mapping and brainstorming the themes of a poem. These experiences will be compiled and indexicalized as conceptual case knowledge into the teachers' mental case libraries, where ideas can be accessed and modified when needed in the future. The teacher's situated knowledge indicates that software is not limited to technological or procedural facility, but rather can be applied as a tool to support different activities under various circumstances. Russell, Bebell, O'Dwyer, and O'Connor's (2003) survey also supports this perspective. Paradoxically, although new teachers report greater confidence in their technology skills than do more experienced teachers, new teachers initially integrate technology less often. The researchers concluded that new teachers failed to understand the value of technology as an instructional tool, but upon becoming more facile with curricula, schools, and other aspects of teaching, they may be better able to explore technology uses in their classrooms. This result reinforces a key assumption of situated perspectives on teaching with technology: teachers must understand both the culture of teaching and the pedagogical value of technology. Case-based approaches, in effect, cannot isolate situated knowledge and skill.

Recently, several Web-based case tools also have been developed to capture and make available conceptual case knowledge for teaching with technology. Hypertext enables the indexing of conceptual case knowledge. One teacher education example is InTime, *the Integrating New Technologies into the Methods of Education project* (*InTime*, see http://www.intime.uni.edu/). *InTime* provides Web-based video vignettes depicting PreK-12 teachers' technology integration practices, with cases that include classroom situations, teacher interviews, and lesson plans. Preservice teachers observe technology integration in the classroom teaching activities of accomplished teachers. Experienced teachers' case libraries are made available in the form of interviews—stories describing how teachers perceive and use technology and why they use it. Teacher stories follow indexing schemes, such as activity overview, learning goals, objectives, assessment, timeline, (instructional) strategies, collaboration (democracy), learning processes (students' information processing), and role of the technology. A search engine provides more detailed descriptors, such as grade level, content area, hardware, software, and preservice teacher technology competency, to readily identify specific video cases. Indexing helps preservice teachers to identify and understand the principles of teachers' experiences (Grabe & Grabe, 2001).

The Knowledge Innovation for Technology in Education Project (*KITE*, see http://kite. missouri.edu/jkite/browse.htm) also provides a suite of Web-based case tools. *KITE* is a Web-based, text-based case library of K-12 teacher and university faculty stories related to technology integration (Wang, Moore, Wedman, & Shyu, 2003). Story indexing was accomplished by carefully reading each story to identify contextual elements (Jonassen, Wang, & Strobel, 2003) such as school location, grade level, reasons for using technology, role of teacher, and assessment of learning, that represent the central organization of the technology integration community, enabling access to common, contextually linked integration dimensions.

Strategic Knowledge

Strategic knowledge, according to Collins et al., (1989), "refers to the usually tacit knowledge that underlies an expert's ability to make use of concepts, facts, and procedures as necessary to solve problems and carry out tasks" (p. 477). In contrast to conceptual knowledge, strategic knowledge is akin to procedural knowledge, that is, "knowing how" and enabling people to perform (Bruning et al., 1999).

Strategic knowledge is particularly germane to constructivist learning environments focusing on problem-based learning (Barrow, 1985; Hmelo-Silver, 2004), anchored instruction (CTGV, 1990; 1997), open-ended learning environments (Hannafin, Land, & Oliver, 1999), goal-based scenarios (Schank, Berman, & Macpherson, 1999), and project-based learning (Krajcik, Blumenfeld, Marx, & Soloway, 1994). Through these environments, students develop problem-solving skills, such as critical thinking, metacognition and self-regulation, self-directed learning, and cognitive flexibility (CTGV, 1997; Ertmer, Newby, & MacDougal, 1996; Hmelo-Silver, 2004; Kolodner, Owensby, & Guzdial, 2004; Slotta & Linn, 2000). Preservice teachers may develop similar benefits via constructivist-inspired, situated learning with cases.

Like conceptual knowledge, situated cognition advocates assert that strategic knowledge is tied to specific situations (Lave & Wenger, 1991). Strategic knowledge is needed to flexibly address the complexity and diversity of problem situations to identify associated conceptual knowledge. Strategic knowledge is often not readily identified or characterized. Expert strategic knowledge, for example, has been described as tacit knowledge and wisdom of practices (Brown et al., 1989; Brown & Duguid, 1996) that are neither easily conveyed nor learned. In the present situated perspective, we characterize four types of strategic knowledge: routinized, reflective, collaborative, and heuristic.

Routinization is a key asset when experts encounter new or novel tasks. Indexicalized information likely contributes to understanding and acting in similar future circumstances and in helping experts apply their repertoires in new circumstances (Brown et al., 1989). Routines result from indexicalization as recurring features of the environment (Perkins & Salomon, 1989). Eventually, situated knowledge becomes highly automated and can be readily applied to specific problems (Greeno, 1991). Leinhardt and Greeno (1986) examined the characteristics of teachers' situated knowledge. Expert teachers worked routinely around a core of activities where they have a large repertoire of indexicalized experience from which to draw, simultaneously responding efficiently and strengthening conditional practices. Routines increase efficiency so that teachers can readily address unexpected events. Beginning teachers eventually gain fluency in core, recurring activities, routinizing some aspects of teaching through repeated experiences and exposure to observation of the experts' practices (Brown et al., 1989). Through situated case-based approaches, opportunities for preservice teachers to apprentice under expert teachers will expedite fluency and routinization of such practices.

On the other hand, routines and automaticity can deter teachers from assessing situations from new perspectives and learning new methods (Putnam & Borko, 1997). For example, preservice teachers who have experienced only traditional teaching models may be oblivious to the potential of alternatives, such as technology, to enhance or extend existing practices. Instead, routinization may engender intractability, thus limiting the potential to improve as reported in teaching with technology literature (Norton et al., 2000; Windschitl & Sahl, 2002).

Reflection is fundamental to constructing situated knowledge. Schön (1983; 1987) proposes two aspects of reflection: reflection-*on*-action and reflection-*in*-action. Reflection-on-action is designed to evaluate the results of an action retrospectively. Reflection-in-action, occurring during activity, is more congruent with a situated cognition view. Experts think and act by assembling sets of principles to explain and predict events. Activity and thinking arise simultaneously and shape each other in order to identify the purpose of activity and assess the current situations (Brown et al., 1989; Collins et al., 1989; Schank, 1999). During authentic activity, preservice teachers are provided opportunities to reflect in their actions and thinking. When they engage expert teachers' cases, they are guided to critically assess the simulated experiences and to distill and personalize conceptual factors from them since expert cases are analogous, not identical, to situations they will encounter (Riesbeck, 1996).

Reflective learners may also perceive better and learn more meaningfully in case-based learning environments. Ertmer, Newby, and MacDougall (1996) examined individual differences in the responses and approaches to learning via case-based instruction, focusing on reflective self-regulation as reflective thinking—the ability and motivation to manage various learning strategies for knowledge growth. Their study indicated that students with high self-regulation benefited more from case-based instruction, demonstrated reflective strategies, and focused more on case analysis processes, while those with low self-regulation benefited less, demonstrated habituated strategies, and focused on facts and right answers. Reflection enables novices to deeply interpret similar but not identical problem situations in order to generate situation-appropriate solutions. Reflection during activity may permit novices to focus on the purpose of the activity, to apply their prior knowledge, and to think and act like experts.

Collaboration is important for novices to participate in communities of practice (Greeno et al., 1998; Lave & Wenger, 1991). In particular, from a situated cognition view, conversation is a central tool for enculturation; sharing conversations and stories conveys the conceptual ideas of the culture and demonstrates membership in the community (Brown et al., 1989). Lave and Wenger (1991) distinguish between types of talking—*talking with* and *talking about*. *Talking with* practices focus on exchanging information related to ongoing activities, while *talking about* practices involve stories or community lore. In situated teacher education with cases, preservice teachers are provided opportunities to talk both with and about practices. For example, when preservice teachers watch expert teachers' video cases as instructors share personal (or other teachers') experiences *about* teaching with technology, they *talk about* practices and share the culture and wisdom of practices. *Talking with* practices occurs continuously through peer feedback about course activities and ongoing conversation with the instructor.

The key for collaboration is the topics they share—whether conversations are situated in the practices of the community or decontextualized. For example, when preparation for teaching with technology focuses on the mastery of technology, the associated discourse between and among preservice teachers and the instructor tends to be framed accordingly. In contrast, when preservice teachers focus on effective teaching practices with technology rather than technology itself, they can adopt technology for their classes in a meaningful way. Teachers also benefit from conversations when the topics include “subject-specific conversations about how modes of inquiry in the various disciplines can be supported with technology” (Windschitl & Sahl, 2002, p. 203). Through ongoing conversation among colleagues and experts, teachers are better able to envision and implement technology in their classrooms (Ertmer, 1999).

Finally, heuristic strategies focus on tacit knowledge and the wisdom of practices. According to Collins et al (1989), “heuristic strategies are generally effective techniques and approaches for accomplishing tasks that might be regarded as ‘tricks of the trade’; they don’t always work, but when they do, they are quite helpful” (p. 478). Heuristic strategies are not easily observed, but are evident in open-ended tasks; consequently, they may not be easily applied to traditional teacher education courses because of the limited time available for open-ended tasks and participation in practices. Although useful heuristic strategies for teaching with technology have not yet been clearly identified, some can be extracted through expert teachers’ cases, work samples, and ongoing conversation with the instructor and peers. Based on such evidence, we may better provide preservice teachers access to the heuristic strategies evident in the practices of experienced practitioners through open-ended activities in university classrooms (e.g., lesson planning and implementing).

Collectively, strategic knowledge provides a type of engine needed to build conceptual case knowledge for sharing within a community, and ultimately to generate new situated knowledge. When preservice teachers gain strategic knowledge linked to the teaching community, they are better able to interpret situations and apply their knowledge—necessary, but not sufficient, conditions to prepare them to become contributing members of the teaching community.

Socially Shared Identities and Beliefs

From a situated cognition perspective, identity is integral to knowledge; identity development is the enculturation process part of learning. Situated cognition emphasizes social practices and person-in-the-world; individual communities construct their own practices and shared meaning through their activities over time (Brown et al., 1989; Lave & Wenger, 1991). That is, novice teachers need to develop their identities and sense of membership in the value and culture of the teaching community.

Several researchers have noted that learners interpret and learn new concepts and practices based on their prior knowledge and beliefs (Marx et al., 1994; Putnam & Borko, 1997; Spiro et al., 1992). In particular, prior knowledge and beliefs influence what and how preservice teachers learn and what they value during preservice teacher education (Putnam & Borko, 1997). Calderhead (1996) provides a useful framework in examining teacher beliefs. Beliefs about *learners and learning*, for example, influence assumptions about the conditions under which students learn best. The teacher who believes that students learn best in open-ended activities provide different tasks than do teachers who believe that students learn best through direct instruction. Beliefs about *teaching* are also influenced by perceptions as to the nature and purpose of teaching. Many teachers, for example, view the purpose of teaching as transmitting knowledge and enact teaching practices accordingly; in contrast, teachers who view the purpose of teaching as facilitating understanding are more likely to focus their efforts on explanations, rationales, and contrast, rather than on accumulating knowledge. Next, beliefs about a *subject area* influence both how it is approached and the associated learning goals. For example, perceiving history as factual knowledge results in different lesson organization and pedagogy than perceiving the historian's perspective to be central. One's views about *learning to teach and learn*, honed by individual experiences, are particularly relevant to preservice education, as prospective teachers are often unaware of the underlying intention of key activities, such as reflection. Finally, beliefs about *one's self and the teaching role* are shaped by personality and relationships, influencing role identification, such as controllers or facilitators, in teaching practices.

Novices negotiate socially shared meaning in order to better participate in social practices and to construct their own meaning. Members in a community are not limited to understanding and reproducing practices through participation in social practices and activities—they also change practices: "The generality of any form of knowledge always lies in the power to renegotiate the meaning of the past and future in constructing the meaning of present circumstances" (Lave & Wenger, 1991, p. 34).

In the context of teaching with technology, teacher beliefs are important because they are an important predictor of classroom technology integration (Pajares, 1992; Russell et al., 2003). Teachers' epistemological and pedagogical beliefs generally focus on learners, learning, and the role of technology, thus influencing conceptions of what is proper and possible in their classrooms (Windschitl & Sahl, 2002). It is also important to identify the shared teaching with technology values and culture in the community.

Ertmer, Ross, and Gopalakrishnan (2000) investigated how teachers' beliefs influence their teaching with technology practices. In their study, most of the exemplary teachers reported student-centered beliefs consistent with constructivist epistemology.

Many additional studies reinforce this finding, reporting that exemplary teachers tend to have constructivist and student-centered pedagogical beliefs, and therefore consider themselves to be facilitators, collaborators, and co-learners with students (Becker, 1994; Becker & Ravitz, 1999; OTA, 1995). Consistent with their beliefs, expert teachers tend to use collaboration, research-based inquiry, hands-on activities, producing, and publishing.

Accordingly, the computer's roles in classrooms are largely dictated by teachers' beliefs. In Windschitl and Sahl's (2002) study, the exemplary teacher enabled students to work collaboratively on authentic projects, describing herself as co-learner with the students. The teacher, whose pedagogical beliefs were student-centered, considered a laptop computer as a tool for students to access a world of information and to create professional products. Likewise, as preservice teachers understand the socially shared identities and beliefs about teaching with technology, their understanding becomes situated in those values and culture. As a result, they learn to apply various types of technology as tools to support student-centered learning.

Situated knowledge varies across communities (Wilson & Meyer, 2000) and is an important conceptual tool of a community: "Conceptual tools similarly reflect the cumulative wisdom of the culture in which they are used and the insights and experience of individuals" (Brown et al., 1989, p. 33). In this respect, situated knowledge includes conceptual case knowledge, routinized, reflective, collaborative, and heuristic strategies, and socially shared identities and beliefs.

Implications for Research

The proposed framework supports several possibilities for future research. Initially, the framework serves as an analytical tool to explain preservice teacher learning through case methods. Although numerous inquiries have been conducted and findings reported, most focus on written case analysis and case discussion stemming from dilemmas. When situated perspectives are used to frame case context and knowledge, learning with cases becomes increasingly authentic. As a result, we can gain insights into what and how preservice teachers learn, as well as how they are likely to interpret and react to highly situated problems.

In addition, we can examine how (or if) case methods facilitate preservice teachers' understanding of expert teachers' situated knowledge—knowledge often difficult to access during initial teacher preparation. For example, one salient benefit is deeply contextualized understanding of otherwise abstract theories, as case methods typically provide examples or problem cases linked to educational theories (Lundeberg, 1999; Merseth, 1996). A related issue concerns whether preservice teachers are better able to apply their contextual understanding in realistic university projects, and ultimately in their field teaching or induction experience. Kim and Hannafin (2005), for example, reported that preservice teachers applied case knowledge to their university course projects. When preservice teachers used the ideas embodied in experienced teachers' cases, they demonstrated conceptual case knowledge by identifying critical concepts (e.g., grades, content area, role of technology, pedagogy) and compared and contrasted expert cases with their own. These findings suggest the near-transfer of case knowledge both to reflective lesson planning for different purposes and in learning to apply preservice teachers' own and expert teachers' knowledge. Research is needed, however, to determine whether this knowledge and skill will transfer to actual, in-field teaching.

In addition, the framework can inform research on teacher learning in situated learning contexts that are not case-oriented. Understanding the nature of teacher knowledge, for example, is critical in refining teacher education curriculum and practice. Research often focuses on cognitive issues, such as teachers' thought processes and changes over time (e.g., Borko & Putnam, 1996). As situated cognition and narrative forms of knowing have emerged, researchers have proposed alternative perspectives to explain the contextualized nature of teachers' knowledge (see examples from Borko & Putnam, 1996). The framework presented in this paper provides a way to understand and study how individual teacher knowledge emerges, as well as how community knowledge is (or can be) shared.

Alternative pedagogical approaches to teacher education have been advanced recently (Putnam & Borko, 2000) and promise to deepen both our methods of study and our understanding of teacher learning. Clearly, however, further research on teacher learning from the situated cognition view is needed. Putnam and Borko (1997) explain:

> In contrast to theoretical and empirical work on classroom instruction and teacher knowledge, we know of no scholars who have examined teacher learning or teacher education programs explicitly from the perspective of situated cognition. Yet, this perspective has implications for both the content of teacher education (What knowledge, skills and understandings do teachers need in order to create classroom situations in which important student learning occurs?) and the process (In what types of contexts should learning activities for teachers be situated?). (p. 1256)

Detailed case study of preservice teachers' learning processes and the nature of situated knowledge provide interesting and practice-grounded ways to advance such inquiries. In this respect, it is important to examine whether preservice teachers *can* learn by interacting with the experiences of expert practitioners, rather than simply reading or hearing about them. In Kim and Hannafin's (2005) study, preservice teachers acclimated to the culture of experienced teachers' technology use. Authentic course projects enabled preservice teachers to begin their enculturation to the technology integration community. Specifically, when asked by the instructor about the details of lesson plans or when exchanging feedback with peers, preservice teachers' conversations reflected several attributes considered "community" values among seasoned, technology-savvy teachers: promoting content learning through technology activity, understanding students' characteristics, and valuing activities that may include, but often go beyond, those involving technology. Preservice teachers and the instructor experienced and practiced *talking with* and *talking about* teachers' practices for technology integration; the culture in the preservice university classroom better approximated the learning culture of practicing teachers.

Finally, the framework can help to bridge the gap between preservice teacher educators' espoused and enacted practice. Virtually all teacher educators concur with the espoused goal of better preparing new teachers to integrate technology into classroom teaching planning and practice, yet few provide the curricula, opportunities, or experiences needed to attain this goal (Gillingham & Topper, 1999; Hargrave & Hsu, 2000). The framework situates technology preparation in teaching contexts, allowing preservice teachers to experience the dilemmas as expert teachers do and to compare approaches. Few technology integration studies have applied situated cognition principles to their methods or employed them to explain teacher knowledge and learning, focusing instead on attitudes toward technology (Brownell, 1997). By applying situated learning with cases as the framework for design and research, we may advance both the teacher education curriculum and the methods of our research.

Conclusions

Although the importance of situated cognition is acknowledged by many researchers and educators, it has proven difficult to apply to preservice teacher learning due, in part, to limitations in time available for learning and the authenticity of activity. However, the potential benefits associated with extending situated cognition and case-based approaches to preservice education practice and research are formidable. We need to continually refine our understanding of both the potential and pitfalls associated with such approaches. The analysis provided in this paper offers a useful framework for conceptualizing disciplined inquiry, advancing research and theory, and influencing practice related to situated, case-based preservice education.

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Table 1.1

Characteristics of conceptual case knowledge, strategic knowledge, and socially shared identities and beliefs

Conceptual case knowledge	• Conceptual and factual knowledge interwoven into contexts and practices (Collins et al., 1989); relating to declarative knowledge • Elaborating through "indexicalized representations" (Brown et al., 1989, p. 37): knowledge structures in various situations • Teachers' conceptual case knowledge in teaching: Knowledge of students, curriculum, content, pedagogy (Leinhardt & Greeno, 1986; Shulman, 1986) • Teachers' conceptual case knowledge in teaching with technology: Technology skills, their integration into curriculum and instructional strategies (Fisher, 1997); understanding of the culture of teaching and the pedagogical value of technology (Russell, Bebell, O'Dwyer, & O'Connor, 2003)
Strategic knowledge	• Ability to use concepts, facts, and procedures interwoven into contexts and practices (Collins et al., 1989; Lave & Wenger, 1991); relating to procedural knowledge *Routinization* • Knowledge that is automated and readily applied to new tasks (Brown et al., 1989; Greeno, 1991) • Increasing efficiency while deterring from assessing situations from new perspectives (Leinhardt & Greeno, 1986; Putnam & Borko, 1997) *Reflection* • Reflection-in-action (Schön, 1983, 1987): Activity and thinking arise simultaneously to identify the purpose of activities and situations (Brown et al., 1989; Collins et al., 1989; Schank, 1999) • Helping novices to deeply interpret similar but not identical problem situations for distilling critical conceptual factors from them *Collaboration* • Participating in communities of practice (Greeno et al., 1998; Lave & Wenger, 1991); conversation: a central tool for enculturation (Brown et al., 1989) • Talking with practices: Exchanging information related to ongoing activities; talking about: exchanging stories and community lore (Lave & Wenger, 1991) *Heuristics* • Focusing on tacit knowledge and effective techniques as "tricks and the trade" (Collins et al., 1989, p. 478) • Not easily observed or applied to developments in education
Socially shared identities and beliefs	• Identity development is part of learning (Brown et al., 1989; Lave & Wenger, 1991); influence of prior knowledge and beliefs to teacher learning (Marx et al., 1994; Putnam & Borko, 1997; Spiro et al., 1992) • Negotiating socially shared meaning by both reproducing and changing practices through participation in social practices (Lave & Wenger, 1991)

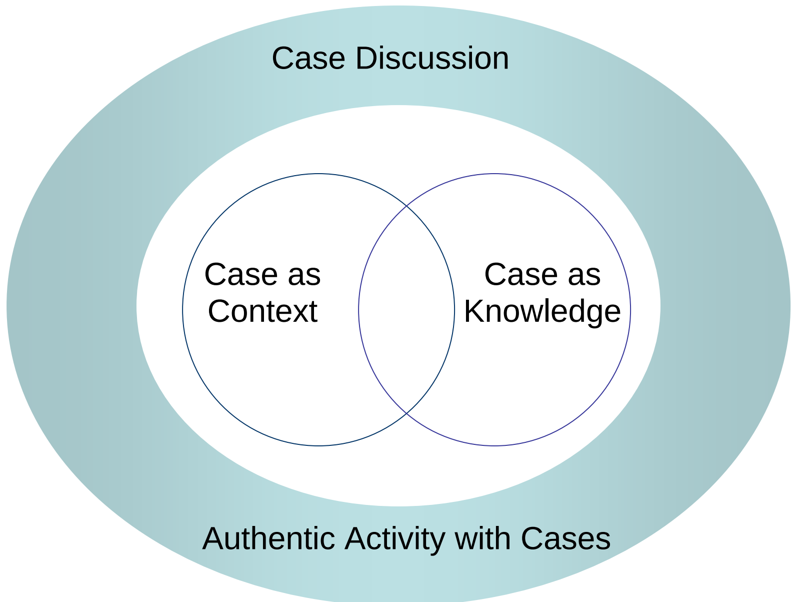

Figure 1.1. Situated learning with cases: Teacher education model.

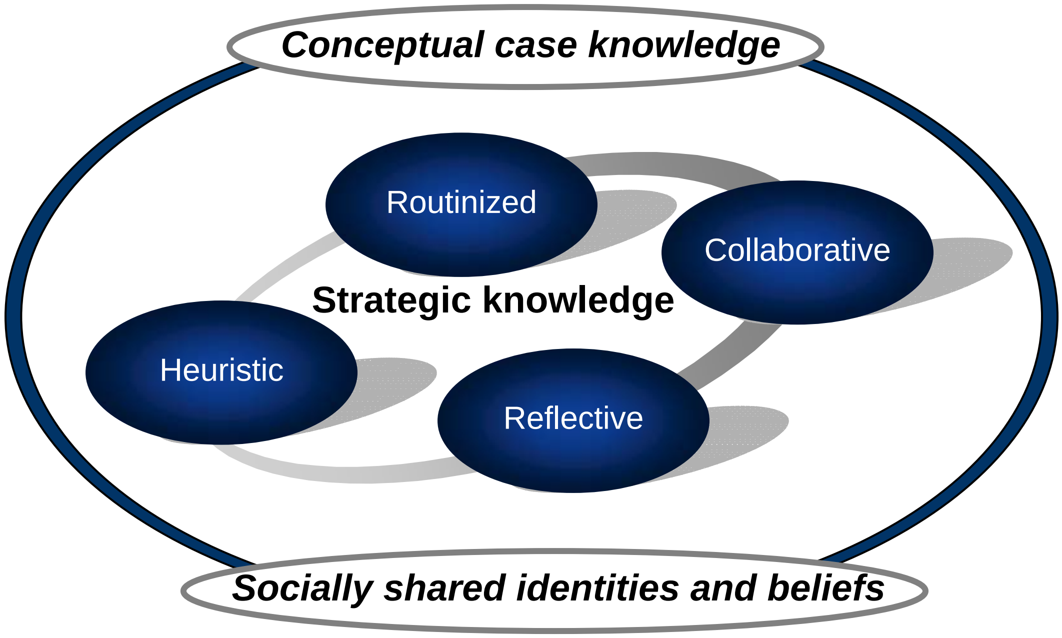

Figure 1.2. Situated learning with cases: Teacher learning model.

CHAPTER 2

GROUNDED DESIGN AND WEB-ENHANCED CASE-BASED REASONING: THEORY, ASSUMPTIONS, AND PRACTICE[2]

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[2] Kim, H., & Hannafin, M. J. Submitted to *Educational Technology Research and Development*, 6/7/05.

Abstract

Cases have been used in education in various ways for many years. In case-based approaches, cases have been used pedagogically to promote complex problem-solving skills in professional education. Recent case definitions and uses have extended beyond their traditional applications. Case-based reasoning (CBR) provides a compelling foundation for case-based learning. Cases are considered to represent knowledge, and the use of cases is considered integral to an individual's problem-solving process. Case-based doing (CBD) builds on CBR research and theory, emphasizing the transition of novices' toward through experts' case-based reasoning and applications. The purpose of this paper is to present the theoretical assumptions and principles for designing grounded, Web-enhanced case-based doing (CBD) environments. Grounded design provides a methodology for designing learning environments consistent with the foundations and assumptions of emerging learning and design theories. Implications for design are presented.

Cases have been used for educational purposes for many years, from the use of pictures or short descriptions as examples for particular concepts (e.g., Collins & Stevens, 1983; Gagné & Medsker, 1996; Merrill & Twitchell, 1994) to the use of *case methods* as a bridge between theory and practice for professional education (Masoner, 1988; Merseth, 1996; Shulman, 1992; Williams, 1992). Case methods, in particular, have served as the basis for a wide range of case studies and case-based curricula.

While traditional methods often include problems, small- or whole-group discussion, and written analysis (Shulman, 1992; Tippins, Koballa, & Payne, 2002), constructivist-inspired learning environments (e.g., The Cognition and Technology Group at Vanderbilt, 1990; Hmelo-Silver, 2004; Spiro, Feltovich, Jacobson, & Coulson, 1992) enable active engagement in problem solving. In these approaches, cases simulate complex contexts; discussion, problem-based learning, and multiple cases support varied applications in education.

Recently, theorists have characterized human cognition and learning using cases, equating individual knowledge with cases as represented and retrieved in the form of stories (Brown, Collins, & Duguid, 1989; Kolodner, 1993; Lave, & Wenger, 1991; Schank, 1999). From this perspective, using cases is not solely a pedagogical method (i.e., case methods), but also represents an expert's habits of thinking. Recent work in case-based reasoning (CBR) (Kolodner, 1993; Kolodner, Owensby, & Guzdial, 2004; Riesbeck, 1996; Schank, Berman, & Macpherson, 1999; Schank & Cleary, 1995) provides important theoretical grounding. Assuming humans think in terms of cases and interpretations of experiences, CBR has significant potential to aid in the support and study of cognition and learning (Kolodner & Guzdial, 2000; Schank, 1999). Through CBR, varied ways of using cases, different frameworks for explaining the effect of case-based learning, and alternative approaches to the design of CBR have emerged. The purpose of this paper is to present CBR as a grounding theory for case-based doing (CBD) environments. We examine the implications of these theories and models for grounded design of Web-enhanced CBD environments.

A CBR Primer

Case-based reasoning has been used as a computational model for intelligent computer systems (Kolodner, 1993), as a cognitive and learning model for humans (Kolodner, 1997; Schank, 1999; Schank et al., 1999), and as a pedagogical approach (e.g., case-based learning aids in Kolodner et al., 2004; goal-based scenarios (GBS) in Schank et al., 1999). Originally developed as a methodology to apply human intelligence to computer systems, CBR has proven useful in developing case-based reasoners (Kolodner & Guzdial, 2000). As a computational model, CBR has been used to develop artificial intelligence systems for classifying, interpreting, scheduling, planning, designing, diagnosing, explaining, parsing, mediating disputes, developing argumentation, and monitoring task execution (Leake, 1996). Such systems often automate or support decision-making (e.g., case-based decision-aids for medical doctors). With artificial intelligence programming techniques and multimedia technologies, many learning environments provide stand-alone software, including simulated case libraries, to help learners (Riesbeck, 1996).

As a cognitive and learning theory, CBR examines how humans solve problems by using an individual's (and others') previous experiences (Kolodner et al., 2004). Figure 2.1

presents an overview of the basic assumptions and processes of CBR—that is, how humans think and act in terms of cases based on their experience.

According to the CBR model, when encountering a problem to solve, we retrieve—often unconsciously—previous experiences in the form of a case relevant to a new situation. Analyzing new problems involves mapping old experiences onto new ones by comparing and contrasting. When the previous case is retrieved, we generate a "ballpark" solution based upon its contents, our interpretation of the new case, and alternative solutions. Assuming a solution from a similar, existing case can be adapted, it is proffered, analyzed critically, and justified before we act on it. The resulting actions are then evaluated during and after application of the solution to new, real-world problems. When unable to solve the new problem using solutions from previous cases, we encounter expectation failure. An iterative process ensues, with candidate solutions evaluated and applied until the requirements of the new case are satisfied. The successful situated information that emerges from this experience provides newly learned (or elaborated) case knowledge.

CBR Components

CBR research, theory, and practice have demonstrated how people think, reason, and act based on their experiences, reflecting a natural model of learning (Schank, 1999). Typically, CBR theories and models focus on basic elements, including case libraries and reasoning in action. Table 2.1 summarizes the major components of CBR.

Case library. According to CBR, individuals store their experiences in the form of personal case libraries (Kolodner 1993; Schank, 1999). A case library is a collection of cases and is often considered a metaphor for individual memories. Experts typically have extensive case libraries, reflecting rich and varied experience in particular domains (Schank et al., 1999).

A case library contains cases and indexes. Cases represent an individual's knowledge as constructed by and modified through experiences (Kolodner, 1993; Schank, 1999). Cases, as knowledge, assume the form of stories with rich plots and include "setting, the actors and their goals, a sequence of events, results, and explanations linking results to goals, and the means of achieving them" (Kolodner et al., 2004, p. 831).

Cases are also developed vicariously by observing or listening to others' experiences. For example, we become familiar with car accidents through various media and others' stories, although we may not have personally experienced an accident. Individuals refine and store cases, such as dialing 911 for emergencies, dealing with insurance companies, interacting with police officers, and applying or receiving first aid, that are associated with *car accident* in their personal case libraries. Others' experiences provide further information used to elaborate case knowledge. Novices often use experts' cases as advice because they lack or have limited relevant personal experiences in a domain area. Artifacts of experts' case libraries function as external rather than individual memories and provide contexts, resources, and advice (Jonassen & Hernandez-Serrano, 2002; Kolodner et al., 2004; Riesbeck, 1996; Schank et al., 1999).

While cases are often used to organize erstwhile ill-structured knowledge, cases can also be captured and shared, providing experiences through which novices begin to examine how experts perceive, interpret, and act (Jonassen & Hernandez-Serrano, 2002). Novices can reference experts' case libraries to guide their problem solving, allowing them to engage authentic tasks and activities in the captured experience of experts (Kolodner et al., 2004; Schank, 1993/1994).

Each personal case library is indexed, which serves to structure individual case knowledge (Schank & Cleary, 1995). Indexing schemes can also codify the critical concepts of a domain and problem-solving strategies of a community (Kolodner & Guzdial, 2000; Schank et al., 1999). Indexes are constructed and refined as individuals identify lessons learned from their experiences and anticipate new situations related to the case. The indexing schema (i.e., organization of abstractions) changes over time as experiences act to strengthen, weaken, or otherwise modify their meaning and utility (Kolodner, 1993; Schank, 1999). Perceptions of experience influence the quality and sophistication of case indexes.

Reasoning in action. According to Schank (1999), case-based reasoning approximates the natural ways people think. Case-based reasoning experiences contribute to and refine the individual's case library. Reasoning in action, the natural human processes facilitated through CBR, involves four subcomponents: goal setting, situation assessment, expectation failure, and explanation.

When a new problem or case is encountered, goal setting both directly influences what one learns and instantiates learning-by-doing processes (Schank et al., 1999). For example, while the complexity of learning to drive an automobile differs between an everyday commuter and a career automobile racer, both still must initially learn to drive a car. Goal setting helps to motivate individuals—beginning through expert—to engage activities in deliberate ways.

Situation assessment is employed during every phase of the CBR cycle. Kolodner et al. (2004) describe situation assessment as "a process of analyzing a new situation so as to understand it better” (p. 832). Given a clear goal, individuals develop expectations, and seek to identify existing, task-relevant cases. Situation assessment occurs because situations are rarely, if ever, identical to each other; as a result, individual memories are modified and adapted continuously.

Indexes, therefore, are inherently dynamic, and thus are continually updated. We interpret new situations based on current indexes in order to establish expectations (*expectation building*) and experience “expectation failure” as we engage the situation (Schank & Cleary, 1995, p. 30). When retrieved experiences do not satisfy the requirements of new situations, expectation failure becomes evident. Individuals identify both areas of understanding and areas where further knowledge is needed. This interpretation enables individuals to initially assess new situations by referencing existing cases, updating and refining case knowledge and meaning as alternatives are assessed and implemented. Consequently, experts develop rich, robust domain (as well as situated) knowledge and experiences, enabling sophisticated organizing, indexing, and applying of their case knowledge. Conversely, novices’ case knowledge and libraries are initially less richly developed and situated, providing fewer existing cases to reference or apply to new problems. Since novices require more time and effort than experts for situation assessment, they must learn to reflect on both their solutions as well as their problem-solving processes (Kolodner & Guzdial, 2000).

Explanation involves reflecting on the process of the experience (Kolodner et al., 2004; Schank et al., 1999). The focus of explanation is to evaluate the results of experience by connecting initial expectations and expectation failure. That is, individuals identify lessons learned from experience and predict their application to new situations. As a result, we develop new cases and case indexes or revise old cases and case indexes in our case libraries. Individual cases and reflections often represent more than global understandings or conventional verbal or procedural knowledge, such as specific lessons learned, critical knowledge relevant to specific situations, and understanding of the values and practices associated with specific communities (Lave & Wenger, 1991). Learners as novices assess not only the final artifacts, but also the alternative processes through which evidence is analyzed and judgments are made. Through this process, novices become increasingly autonomous in their self-assessments, learning when, why, and how to use their case libraries (Schank, 1999).

Case-based reasoning has important, though largely untapped, educational implications for supporting novices in case-based environments—particularly via the affordances of technology (Kolodner et al., 2004; Schank et al, 1999). Case-based reasoning provides a useful frame for understanding how deep understanding emerges, as well as how novices learn and develop their expertise through both personal experience and by deliberately accessing and engaging expert case knowledge (Kolodner et al., 2004). Researchers have proposed learning-by-doing models (see, for example, Schank et al., 1999; Kolodner, Crismond, Gray, Holbrook, & Puntambekar, 1998; Kolodner, Hmelo, & Narayanan, 1996), enabling novices to engage case-based problems or tasks using the affordances of computer technology. Moreover, consistent with apprenticeship models, CBR environments underscore the importance of learning by doing under expert guidance (Schank, 1994/1994; Stevens, Collins, & Goldin, 1982). In the following section, we examine how CBR principles can be instantiated using Web technology to make expert case knowledge accessible to novices and describe principles and methods appropriate to grounding such practices.

Grounded Design of Web-enhanced CBR Environments

According to Hannafin, Hannafin, Land, & Oliver (1997), grounded design involves "the systematic implementation of processes and procedures that are rooted in established theory and research in human learning" (p. 102). To effectively ground design practice, four conditions should be met: (1) designs must be based on a defensible theoretical framework that connects key foundations and is consistent with assumptions associated with those foundations; (2) methods must be based on empirically verified approaches; (3) design must be generalizable and adaptable to systems with similar foundations and assumptions; and (4) designs and their frameworks must be validated through continuous implementation. Table 2.2 identifies grounded design foundations, and summarizes how theory, research, and practice influence the design of Web-enhanced CBR environments. While each is described individually for clarity, the foundations are interdependent in practice.

Cultural Foundations: Influence of Context

Cultural foundations shape the values and beliefs underlying a learning environment (Hannafin et al., 1997). Many CBR environments are considered to be constructivist-inspired (Kolodner 1997; Schank, 1999; Stevens et al., 1982) in that researchers assume that understanding evolves through ongoing experiences. Case-based reasoning emphasizes learning-by-doing as a way to both experience and learn (Kolodner et al., 2004; Schank et al., 1999), increasing the authenticity and meaningfulness of the experience.

Accordingly, constructivist approaches and values for learning-by-doing help to establish the overarching context and associated design requirements. Many teacher educators, for example, have suggested that teaching involves ill-structured, context-specific, continually evolving activities, as well as problem solving in the world of professional practice (Merseth, 1996; Schulman, 1992). Teacher educators and researchers suggest that prospective teachers will both learn and implement technology more successfully in their future classrooms when preservice experiences are better situated in authentic teaching problems and experience. Novices, such as beginning teachers, need to engage increasingly meaningful technology-based teaching activities (Becker, 1994; Becker & Ravitz, 1999; Chisholm & Wetzel, 1997; Office of Technology Assessment (OTA), 1995; Pierson, 2001; Russell, Bebell, O'Dwyer, & O'Connor, 2003). For example, in a Web-enhanced CBR preservice education course in technology integration (Kim, Hannafin, & Thomas, 2004), authentic learning-by-doing activities (e.g., integrating software into instruction, developing concept maps for lesson presentation, implementing technology-enhanced lesson activities) were identified as being consistent with the values and practices of teacher education and technology integration communities. Lacking opportunities for first-hand experience integrating technology into their own classrooms, beginning teachers appear to benefit more from engaging expert teachers' perspectives and experiences in authentic classroom contexts than from focusing on technology mechanics (Ertmer et al., 2003; Gillingham & Topper, 1999; Howard, 2002).

In addition, the cultural values specific to a given community influence the design of the learning environment. For example, in Kim et al.'s (2004) study, an introductory computer course for prospective teachers dictated unique contextual requirements and values within teacher education and technology integration communities. Different implementations likely support other contextually-defined needs, such as the infusion of technology to teach subject matter content, introductory pedagogical methods for technology in a specific methods course, or the mastery of technology skills or software. In each of these instances, the contextual values define which (and whether) CBR activities for technology integration can be aligned.

Psychological Foundations: CBR's Situative Perspective

Psychological foundations emphasize how we think and learn, guiding both the specification of learning goals and associated pedagogical approaches (Hannafin et al., 1997). Researchers and theorists describe the importance of individual and socially-constructed case libraries, as well as reasoning, in CBR environments (Kolodner et al., 2004; Schank, 1999). Two psychosocial assumptions associated with CBR learning environments are key to CBR: development of case libraries and participation in the social practices of a community.

Case-based reasoning's conception of case libraries is consistent with assumptions attendant to the situated nature of knowledge. Individual cases comprise knowledge and indexes that are situated in particular experiences. Knowledge is presented in the form of stories (Lave & Wenger, 1991)—that is, cases reflect the cultural values, insights, and experiences of individuals (Brown et al., 1989; Shulman, 1992). As knowledge, individual cases are indexed in terms of their purposes, as well as similarities and differences between and among cases. Expert case indexing represents the major concepts of the domain and their relationships as understood by individuals with extensive experience or expertise (Kolodner & Guzdial, 2000).

Knowledge in the form of a case evolves continually through repeated experience and, as a tool, is applied in relevant new contexts (Brown et al., 1989; Schank, 1999). Through repeated experiences, we internalize knowledge in the form of cases. The cases, however, are not isolated from the culture and context of a community; rather, knowledge is situated in social and physical contexts (Brown et al., 1989). Novices become increasingly knowledgeable as they communicate with experts, use the conceptual tools of a community, and otherwise experience the practices of a community. Therefore, participation in social practices is essential in building knowledge valued by and relevant to a given community. Although CBR's situative perspective focuses on the individual nature of learning and cognition, individual cases, as individual experiences, are shaped by social practices and everyday contexts (Schank, 1999).

Pedagogical Foundations: Differentiating CBR Tasks and Activities

Pedagogical foundations stress how content is represented and affordances provided to support learning, reflecting the influence of underlying assumptions, research, and theory in the design of CBR activities (Hannafin et al., 1997). Case-based reasoning pedagogy supports situated learning by enabling novices to engage authentic tasks as an apprentice under the tutelage of virtual and live experts. For example, Kim et al.'s (2004) case-based doing (CBD) model consists of authentic tasks, a succession of activities (*scenario work, what's the story, planning, doing,* and *telling your story*), instructor support, peer review, and Web resources. Figure 2.2 illustrates the structure of CBD.

Authentic tasks and activities help introduce novices to expert reasoning related to real-world dilemmas and problems. Having multiple opportunities to engage authentic tasks helps to refine one's understanding of complex concepts in diverse situations, further refining and deepening situated knowledge (Brown et al., 1989). For each task, novices are prompted to engage CBD activities as they learn how experts analyze problems and dilemmas, and then to practice reasoning and "doing" skills as they acquire and apply new knowledge.

Scenario work is designed to support novices in conducting an initial situation assessment by identifying relevant contextual information, goals, deliverables, and scope. In principle, once novices determine personally relevant task scenarios, they develop expectations for their tasks (Schank et al., 1999) by assessing why they chose the scenario, whether completion is feasible, and which resources are needed. In practice, since novices typically lack a deep understanding of the task context, they tend to develop superficial scenarios. Their scenarios are often too simple to be worthwhile or too complicated or unspecified to be resolved. Therefore, novices require guidelines and support during their scenario work.

Hannafin, Land, and Oliver (1999) proposed alternatives to guiding learners in interpreting situations, such as those encountered in CBR. *Externally imposed contexts* explicitly define the parameters of a problem or situation; learners, in turn, determine which solutions are appropriate to the defined task. *Externally induced contexts* frame a broad situation, but learners must interpret, identify, and generate specific problems to be addressed. Thus, an externally induced context might have a range of problems that could be addressed in a variety of ways. Finally, *individually generated contexts* are created individually based on unique problems or interests. Learners create their scenarios based on their unique preferences, needs, and situation assessments. For novices, scenario work is influenced by the knowledge and skills required to engage the task, individual ability, age, maturity, and task familiarity. For example, externally imposed scenarios may be suitable for beginners who lack background knowledge, skills, and experience, as the parameters of the task will need to be made explicit and obvious; individually generated context, in contrast, may be appropriate for mature, knowledgeable, and experienced individuals. As individuals transition from novice to expert, externally induced scenarios, reflecting progressively greater complexity and requiring greater reasoning, serve to bridge the novice-expert expertise and experience gap.

The *what's the story* prompt is designed to support interpretation and analysis of exemplar cases relevant to given tasks and scenarios. Whereas experts readily utilize the knowledge and skills represented in their case libraries, novices do not; rather, they tend to oversimplify or poorly interpret case libraries based on their limited understanding (Schank, 1999; Spiro et al., 1992). Left unassisted, novices typically engage in trial and error activities (or are unable to interpret tasks or events). By deliberately examining expert-generated cases relevant to their needs, novices engage tasks and events otherwise beyond their individual capabilities (Kolodner et al., 2004; Schank, 1999).

Opportunities for case interpretation are provided during case discussion and written case analysis. Case discussions are often led by a facilitator who leads question and answer sessions that guide novices to concepts otherwise overlooked. The facilitator becomes a "planner, host, moderator, devil's advocate, fellow-student, and judge—a potentially confusing set of roles" (Barnes, Christensen, & Hansen, 1994, p. 23). Moreover, facilitated case discussion stimulates dialog in the form of stories between old and new members and extends community lore, experiences, and practices (Carter, 1989; Lave & Wenger, 1991).

Written case analysis also helps novices learn how to interpret cases. Guidance is needed to support understanding of experts' cases; unguided, novices tend to analyze experts' cases based only on their limited understanding and subjectivity. In CBD, templates (e.g., prompt questions or titles) guide the focus of activities. For example, the *Case Interpretation Tool* in Owensby and Kolodner's (2002) *Case Application Suite* enables learners to analyze and understand expert cases relevant to their design work. Learners describe their case analysis using specific prompts, such as time and location, problems, benefits, solution(s) chosen, alternative solutions, solution implementation, technology used, criteria applied, and advice for others. Detailed prompts are provided, such as: "Where and when did this challenge take place? Be as specific as possible in telling the sequence of events." Hints are also provided to support case analysis (e.g., "Think about that place and time and the effect that it had on the challenge the experts faced"). The *Case Interpretation Tool* subsequently helps novices to develop their own cases by guiding their initial interpretation and understanding of expert cases. Since cases are analogs and not identical to the unique situations novices encounter, interpretation helps to clarify experts' experiences and relate them to the novice's own cases (Riesbeck, 1996).

During *planning*, novices brainstorm their ideas and plans for completing their scenarios. They conduct situation assessment for their new task, identify possible solutions for their goals, choose ballpark solutions among candidate ideas, and anticipate the results and pitfalls of the solutions. In the planning phase, expert cases scaffold the process of applying the expert's ideas to the novice's scenario, attempting to highlight how experts address comparable dilemmas. This can prove difficult for novices, as they are often unable to distinguish which cases are applicable and what concepts are useful—that is, the similarities and differences between an expert's cases and their own situations (Owensby & Kolodner, 2002; Kolodner et al., 2004). Deliberately scaffolded identification of lessons learned guides novices as they learn to apply expert cases to their cases.

Next, the *doin*g phase is designed to support novices as they act on their plans. Doing may range from developing products and playing piano to cooking food (Kolodner et al., 2004; Schank et al., 1999). Although doing focuses on performance, it requires that individuals reflect on their actions by comparing and revising their plans. During these processes, learners encounter expectation failures when their plans do not work as intended, providing opportunities to evaluate plans and to conduct deeper situation assessments. Expectation failure, in CBD, provides teachable moments for supporting or disproving working theories and assumptions.

Peer collaboration is also important. As individuals generate and share ideas with others, they practice how to articulate ideas and warrant claims while encountering alternative, sometime competing, perspectives (Brown et al., 1989). These interactions introduce novices to the culture and conventions of a given community of practice as they learn to share, interact with, and critique the ideas and actions of peers (Brown et al, 1989; Lave & Wenger, 1991). For example, Kolodner and Nagel's (1999) *Design Discussion Area* guides learners as they collaboratively share their experimental results, design plans, and results to both help (and learn from) others and to facilitate group discussions. As a result, learners articulate more about their own (and others') work and strengthen their understanding (Kolodner et al., 2004).

The final phase, the *telling your story* prompt is designed to support reflection and transfer as individuals reflect holistically on their experiences. In CBD, participants are asked to briefly describe their experience in the form of a story to recall specific concrete, contextual incidents along with perceptions about the events. It is important that participants reflect on critical incidents or concepts related to their personal accounts, as they identify lessons learned, analyze reasons for impasses, and propose alternatives to address future problems or dilemmas. Individual lessons learned may include a broad range of knowledge and skills, such as conceptual understanding, beliefs, and know-how.

After learners reflect on their own activities, each one writes a letter to a peer novice who may encounter a similar dilemma or challenge in a different situation, allowing the learners to examine potential transfer to new situations. Letters serve to promote membership in the community by relating the experiences of a slightly more seasoned practitioner to a less experienced novice (Lave & Wenger, 1991). While learners engage in the *telling your story* phase, they construct and share their stories, formalizing and indexing their case knowledge.

Technological Foundations: Computer-supported Apprenticeship

In grounded design practice, technological foundations refer to the range of media available to support learning (Hannafin et al., 1997). Some learning environments use the affordances of computer technology to simulate real-world tasks and to conduct meetings with virtual advisors. Web affordances, for example, support a range of CBD activities, including the creation of and access to expert and individual case libraries and a host of user activities. Figure 2.3 presents an example of the case-based doing tool (CBDT) designed to help preservice teachers to develop technology-enhanced lesson plans and instructional materials (Kim et al., 2004). Case-based doing tool presents expert teachers' case libraries and an activity support tool for preservice teachers who typically lack the experience, and immediate classroom context, to engage in real-life applications of technology in everyday teaching. Two CBDT features are particularly relevant: the Web-based case library and the activity support tool.

Web-based case library. Case libraries are assembled by collecting and indexing expert (and peer) cases. Recently, Web-based case tools that support professional education have been reported (e.g., Derry & The STEP Team, in press; Ertmer, Ross, & Gopalakrishnan, 2000; Schrader et al., 2003). These case tools often include problem or exemplary cases, or vignettes. In CBDT, cases reflect “the presence of experts” (Riesbeck, 1996, p. 59), including the situated knowledge and perspectives of experts that function to advise or guide. Case-based doing tool cases include experts’ stories (via interviews) in the form of narratives that enable novices to better understand the interpretations and actions of experts in context.

Web and computer affordances support multiple formats for representing expert cases. Novices can access rich information from experts’ interviews, captured real situations, work samples, and other archival data for each case (Kim, Hannafin, & Kim, 2005). While the expert instructor can draw upon a wealth of stories or demonstrations based on personal experience, novice teachers often cannot relate to them due to limited real-world teaching experience (Carter, 1990). Multimedia cases provide multiple ways to present cases and relevant contextual information to increase both authenticity and meaningfulness.

Web affordances, such as hypertext links and search engines, allow rapid access to expert cases and independent resources. Because well-designed tools help to simulate the retrieving of memories in personal case libraries, learners can practice finding and using knowledge during their own problem solving. For example, the Knowledge Innovation for Technology in Education Project (KITE, http://kite. missouri.edu/jkite/browse.htm) case library contains a wide range of captured faculty and teacher experiences related to technology integration (Wang, Moore, Wedman, & Shyu, 2003). In KITE's story index, cases are organized in detailed index schemes, such as school location, grade level, reason for using technology, role of teacher, and assessment of learning; these represent critical technology integration concepts and contextual information of the community (Jonassen, Wang, & Strobel, 2003). Novice teachers can locate relevant expert cases appropriate to their own situations via different search options: Super search, Keyword, and Browsing. Indexing schemes, such as those used in KITE, codify expert teachers' case libraries to guide novice users to retrieve and apply them in similar situations (Kolodner, 1993; Schank, 1999).

Web-based activity support tool. The role of activity support tools is to help learners conduct their investigations by recording and reflecting on their problem-solving processes (Kolodner et al., 2004). During CBD learning activities, novices can become overwhelmed by the complexity and ill-structured nature of authentic problems. Technology, therefore, assists novices in identifying and organizing problems (Kolodner et al., 2004). Novices have opportunities to apprentice under more seasoned and experienced mentors by using computer-based tools in the form of templates, simulations, and live teachers (Riesbeck, 1996; Schank, 1993/1994; Stevens et al., 1982). For example, guiding questions (e.g., "How does technology facilitate your student learning?") or templates (e.g., "the strategies of collaboration") in lesson planning tools help to situate reasoning and actions for teaching with technology.

As a template is used to support activity, the *Reflective Learner* tool (Turns, Guzdial, Mistree, Allen, & Rosen, 1997) helps students to structure stories about their experiences. Based on CBR principles, the tool prompts by explicitly asking students (1) to identify a problem during the project, (2) to describe their solution to the problem, (3) to address lessons learned from the experience, and (4) to anticipate similar situations. Through interviews and discussions, the researchers found that students reported this activity helped them to understand what they were doing (and why). Such structures also enabled other novices to search and locate reasoning processes embodied within the case.

Computerized goal-based scenarios (GBS) provide programmed steps and concrete guidance. The *Scenario Operations* of Schank et al.'s (1999) *Advise the President* program, for example, include "asking experts for opinions on topics relevant to completing the report, compiling information for future reference, making claims about strategies, and backing up claims with selections from the information the learners compiled" (pp. 175-176). The guidelines amplify goal-relevant activities, thereby minimizing extraneous aspects of complex scenarios. Computers can provide concrete, authentic, and timely feedback when expectation failure is encountered. In a GBS, both live and automated coaches and experts can simulate consequences, advise participants based on progress, or provide feedback in the form of domain experts' stories.

Pragmatic Foundations: Bridging Knowledge and Experience Gaps

Pragmatic foundations address unique situational constraints associated with design and implementation, ensuring practical designs that are appropriate to given problems and settings (Hannafin et al., 1997). Case-based reasoning learning environments typically include realistic projects that require individual or collaborative activities. The authenticity of activities allows participants to gain experience in the essential practices of a community. Novices, however, are often unable to follow or understand initial activities that are complex; the novice's transition into a community of practice requires the scaffolding of CBD activities (Lave & Wenger, 1991).

Scaffolding can be provided by computer-based tools, the instructor, peer collaboration, and Web resources to clarify the context of the performance, support novices' actions, and otherwise guide them as they engage problems or tasks. Several types of scaffolds can be provided. For example, while goal-based scenarios are used extensively in computer-based simulation tools, live GBSs can be utilized for role-playing simulations in situations where computers are not available or appropriate (Schank et al., 1999). Scaffolding via live GBSs may assume the form of standard scripts or dynamic expert feedback before, during, or subsequent to performance. Learners can practice communication, human relation, and reasoning skills, as well as develop and refine domain knowledge and skills.

The relevance of cases to real-world situations, contexts, and events is central to CBD. The model enables novices, otherwise unable to have real-world experiences, to engage authentic problems and activities in classroom settings. Cases, a blend of actual and realistic situations, provide a bridge between theory and practice as "a piece of controllable reality, more vivid and contextual than a textbook discussion, yet more disciplined and manageable than observing or doing work in the world itself" (Shulman, 1992, p. xiv). To this end, cases enable opportunities for problem solving and simulated decision-making where actual experience is impractical, too time-consuming, or exceedingly complex for novices to otherwise engage (Spiro et al., 1992).

Implications for CBD Design

Grounded approaches to the design of Web-enhanced CBD environments have important implications for the design of experts' case libraries, use of the case libraries, design of performance activities, participation in social practices, and the development of learners' case libraries. These implications are summarized in Table 2.3 and detailed in the following section.

Designing and Indexing of Experts' Case Libraries

Case libraries are designed to capture experts' stories—their experiences, knowledge, strategies, beliefs, and insights (Kolodner, 1993; Schank et al., 1999). When sufficiently analogous to situations encountered by novices, they both embody the reasoning of the expert and guide novices in their reasoning (Kolodner et al., 2004). In order to identify which cases are appropriate for novices, cases need to provide rich information, including experts' stories about their experiences engaging particular tasks, artifacts associated with expert decision making and acting (e.g., experts' design drafts and products), and appropriate situational contexts (e.g., video including the experts and other participants). For example, *Integrating New Technologies Into the Methods of Education* (*InTime*: http://www.intime.uni.edu/video.html) provides 60 online video vignettes featuring PreK-12 teachers integrating technology into their classrooms. Web-based video cases include real classroom situations, expert teachers' stories, and artifacts of the teachers' lesson plans accessible via hypertext and a search engine.

To collect cases and generate case libraries, a designer or instructor must determine a useful case indexing scheme. Initially, case indexing serves to formalize experts' knowledge structures, such as background information (e.g., when, where, who), critical concepts, task goals, particular problem solving skills (e.g., time management), expectation failures, lessons, and resources (Jonassen et al., 2003; Kolodner et al., 2004; Schank et al., 1999). In CBD, indexing also supports both organization of and access to case knowledge and reasoning by the novice. The content, organization, and structures of expert cases must anticipate likely learners' goals, tasks, courses, and impasses, so as to help novices to find and use experts' cases appropriately and efficiently. For example, in the Web-based case library for a turfgrass management course (Colaric, Turgeon, & Jonassen, 2002/2003), cases were organized to reflect both basic information (e.g., title, geographic location, turf species at the problem location, turf type, brief description of the cases) and a problem framing and solving framework related to course tasks and problems (e.g., actions for correcting the problem, rationale for actions, expected results, results of actions, and unexpected results).

Analyzing and Using Experts' Case Libraries

Analyses is designed to support novices as they seek to vicariously understand expert knowledge, problem solving strategies, and reasoning and apply them to their own work (Kolodner et al., 2004; Schank et al., 1999). Discussing cases and writing case analyses helps to deepen and personalize understanding of experts' cases. Teacher-led or group case discussions, for example, have been used widely in professional education because they allow participants to develop increasingly complex understandings and skills in the domains, situations, and practices of a community (Masoner, 1988). Case discussions need to amplify the experts' understanding of the specific knowledge, skills, and perspectives of the corresponding community (Kolodner et al., 2004; Schank et al., 1999):

What plans were developed to achieve the goal? What activities were involved in implementing the solution? What problems were encountered? (Kolodner 1993; Kolodner et al., 2004). Written case analyses subsequently help individuals to personalize their understanding. Novices need to summarize case discussions and articulate their understanding as they transition to applying the cases for their own purposes. Written case analysis, therefore, should include a brief description of the situation, problem solving processes (problems, solutions, and results), and activities of the case.

Designing the structure of CBD Activities

Case-based doing (CBD) activities should enable novices to engage experts' authentic experiences and activities in controlled settings. Case-based doing activities often focus on hands-on or "doing" activities, which may prove ineffective when they lack authenticity. Authentic tasks and activities simulate the contexts, activities, resources, and reasoning of a corresponding community (Kolodner et al., 2004; Schank et al., 1999). Therefore, a CBD designer or instructor must first identify the characteristics of the authentic tasks for a particular domain in terms of importance, difficulty, time, and cost. The activities should provide multiple tasks and be ordered, where possible, from simple and easy to complex and difficult to provide transitional activities that can be progressively scaffolded. Case-based doing activities need to be organized progressively to reify the case-based doing stages: *scenario work, what's the story, planning, doing,* and *telling your story*. For example, in Kim et al.'s (2004) application of CBD to support preservice teachers' integration of technology education included scenario work. Preservice teachers were asked to create their own lesson situations, including the characteristics of target students, subject matter, curriculum standards, and initial ideas of pedagogy, as well as to apply expert case knowledge to their situations, develop and refine initial plans, implement their plans, and reflect on their planning and actions. Since novices often experience difficulty while engaging complex, authentic tasks, scaffolding was provided to assist preservice teachers in completing their tasks, using prompt questions and templates to identify, seek, and comprehend relevant concepts. Therefore, it is important to determine the type (e.g., scaffolding for project procedures, understanding of the concepts of a domain), location, and timing of scaffolding needed to engage CBR. In addition, designers and instructors need to identify other alternatives to strengthening participant activities, such as providing instructor-expert explanations, demonstrating, providing feedback, coaching, and guiding to other resources.

Participating in Social Practices

Case-based reasoning provides a fundamental way to learn the practices and perspectives of a community. A designer or instructor can influence learners' motivation to participate in social practices that contribute to their learning. During analysis, for example, case discussions may facilitate the novice's role as apprentice by initiating conversations with experienced practitioners (Carter, 1989). Since initial understandings tend to be segmented (Schön, 1983), discussion helps novices to gain a holistic understanding through the experiences and perspectives of the expert; novices, in turn, can compare and contrast their own experiences and perspectives with those of experts. Careful structuring of cases, in the form of templates, as well as systematic use of case analyses and experts' case libraries, helps novices to identify case knowledge appropriate to their needs (Kolodner et al., 2004). For example, *the Case Authoring Tool (CAT)* provides experts' cases with prototypical novice prompting questions so that expert conventions and practices embodied in the cases can readily identified and understood. According to Kolodner et al. (2004), effective prompting should include “the solution, science and technology used, alternative implementations, the criteria (i.e., what criteria were used to selected a solution?), favorable outcomes, [and] unfavorable outcomes” (p. 843).

Peer collaboration, such as peer feedback, collaborative work, and discussions, provides different types of opportunities to engage in social practice. Conversation is a basic tool for interacting with peers (Lave & Wenger, 1991). When the topics of conversation are situated in authentic tasks and activities, conversations share the lore, skills, beliefs, and culture of the community. Example questions to stimulate peer collaboration might include: What might go wrong if your partner’s plan is implemented? What needs to be clarified in your partner’s product? What might improve your partner’s written case analysis?

Instructors, or facilitators, also scaffold novices’ transition into the social practices of a community. Instructors, as experts, scaffold by providing explanations, demonstrations, feedback, evaluations of progress, and alternative approaches when novices encounter impasses. Instructors can also relate personal experiences beyond those documented in expert case libraries. For example, when learners face difficulty in allocating time for a task, the instructor can provide explanations and demonstrations, as well as examples of successful approaches and ideas about the time required for subtask completion. In addition, instructors can provide feedback on learners’ plans and timelines, raising issues not yet envisioned and calling attention to especially useful or creative approaches tendered by the novice.

Developing Learners' Case Libraries

The development of individual case libraries is designed to facilitate meaningful reflection and transfer of knowledge and skills (Kolodner et al., 2004; Schank et al., 1999). Novices should be encouraged to document their own indexed stories, including key concepts and insights during task completion—a natural way of storing (Schank, 1999) and sharing knowledge and experience with members of a community (Lave & Wenger, 1991). During the reflection phase (i.e., *telling your story*), novices reflect upon lessons learned from their experience and predict future situations to which their lessons may apply (Kolodner et al., 2004; Schank et al., 1999). Reflections include the processes of accomplishing the task, evaluating individual (and other) solutions, developing alternatives, considering difficulties and task complexity, managing time, and contemplating applications in the future. Case libraries may also be refined by sharing feedback with peers, publishing on the Web for other learners, and providing advice to other novices.

Conclusion

By applying grounded design principles in practice, CBR provides an important approach—especially for situated learning with cases. Through technology-enhanced CBR, novices may gain access to the experience and wisdom of veteran members of the community, helping them to understand the culture of practices and decision-making of experts and improving their reasoning skills. However, while case libraries have a rich history in computer science (Kolodner & Guzdial, 2000), the technologies and methodologies of CBR-informed teaching and learning are still emerging. Grounded design principles should help to guide emergent technology-enhanced CBR approaches, ensuring that both design processes and pedagogical activities are informed by, and contribute to, available research, theory, and practice. In addition, the effectiveness of CBR learning environments needs to be verified through iterative implementation. Many researchers emphasize the importance of the longitudinal study for newly designed learning environments in order to deeply understand complex educational phenomena (Design-Based Research Collective, 2003; Hannafin et al., 1997; Reeves, Herrington, & Oliver, 2005). Through iterative implementation, designers may better align the learning environments with CBR theory.

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Table 2.1

CBR Components

Case library	<u>Cases</u> • Cases as one's own knowledge in the form of stories constructed by experience (Kolodner, 1993; Schank, 1999) • Consists of plots, such as "their setting, the actors and their goals, a sequence of events, results, and explanations linking results to goals, and the means of achieving them" (Kolodner et al., 2004, p. 831) • Cases as others' knowledge constructed by listening to and observing; roles as contexts, resources, and advice to solve one's own problems (Jonassen & Hernandez-Serrano, 2002; Kolodner, 1993; Kolodner et al., 2004; Riesbeck, 1996; Schank et al., 1999) <u>Case indexes</u> • Organization of memories; knowledge structure (Schank, 1999; Schank & Cleary, 1995) • Indexing: Good case indexes are easily used for future (Kolodner & Guzdial, 2000; Schank et al., 1999) • Index schema: Definition of the scheme; used to codify the critical concepts of a domain and problem strategies of a community (Kolodner, 1993; Schank, 1999)
Reasoning in action	• *Goal setting*: When new problem is encountered; influences what-to-learn and how; motivates people to engage the activity (Schank et al., 1999) • *Situation assessment*: Analyzing new situations that are incompletely interpreted by the relevant old cases; hypothetical interpretations; expectation building; interpretation by referencing the old cases as knowledge (Kolodner et al., 2004; Schank & Cleary, 1995; Schank et al., 1999) • *Expectation failure*: When old cases do not work for new situation; helping to identify needs and to conduct self-assessments (Schank, 1999) • *Explanation*: Evaluating the results of expectation failures; identifying lessons and predicting their applications; developing new cases and case indexes or revising the old cases (Kolodner et al., 2004; Schank et al., 1999)

Table 2.2

Grounded Design for Web-enhanced CBR Learning Environments

Foundations	Assumptions and Principles
Cultural	• CBR as a constructivist environment (Kolodner 1997; Stevens et al., 1982) • Importance of authentic activity (Kolodner et al., 2004; Schank et al., 1999) in the broad and specific context of the community
Psychological	• CBR as a situative perspective • Case libraries as collective memory; cases as knowledge, including situations, concepts, culture, insights, and experiences of individuals (Brown et al., 1989; Kolodner & Guzdial, 2000; Lave & Wenger, 1991; Schank, 1999) • Participation in social practice for building knowledge (Brown et al., 1989; Lave & Wenger, 1991; Schank, 1999)
Pedagogical	• Case-based doing (CBD) model: Repeated authentic tasks; authentic activity; support by the instructor, peers, and Webresources. <u>*Five authentic activities*</u> • *Scenario work*: Creating learners' task context; conducting initial situation assessment; the extent of guidance—externally imposed context, externally induced context, and individually generated context (Hannafin et al., 1999) • *What's the story*: Case analysis for interpreting experts' cases in the case library relevant to learners' task; teacher-led case discussions and written case analysis; situation assessment by comparing experts' cases and learners' tasks • *Planning*: Situation assessment by proposing solutions; using experts' cases for planning learners' projects • *Doing*: Reflective action upon one's plans; encountering expectation failure; sharing feedback on learners' and others' work • *Telling your story*: Reflecting on solutions and processes for learning experience; identifying lessons learned and proposing the solutions for the future; telling learners' stories by writing a letter to a novice in a new situation
Technological	• Computer-supported apprenticeship (Riesbeck, 1996; Schank 1993, 1994) • Web-based case libraries: Multiple formats of experts' data; random access by using hypertext linking and search engines • Web-based activity support tools: Recording and reflecting on problem-solving processes and organizing tasks into a manageable size; the format of a template or simulation; providing concrete, authentic, and timely feedback
Practical	• Feasibility of authentic activity and technology in terms of cost, time, and learners' abilities: Computer-based simulation vs. live role playing simulation (Schank et al., 1999) • Legitimacy of experts' cases: Between real-world situations and made-up realities; controllable reality, more disciplined and manageable cases than real situations (Shulman, 1992); displaying multiple cases in the case library for particular concepts (Spiro et al., 1992)

Table 2.3

Implications for Designing Web-enhanced CBD Environments

Implications	Design principles and activities
Designing and indexing experts' case libraries	• Develop or select experts' cases that are similar to learners' tasks • Include experts' stories about their experiences with particular tasks and, for rich information, also include artifacts (e.g., experts' design drafts and products) and situational vignettes (e.g., video of a scene that includes the experts and other participants) • Determine the scheme of the case indexes: Index based on the knowledge structure of the experts of a particular domain, including, but not limited to, background information, critical concepts, task goals, particular problem solving skills, expectation failures and lessons, and resources; index based on expected learners' needs, including learners' goals, courses, and impasses
Analyzing and using experts' case libraries	• Design case analysis for learners to have a deeper understanding of the experts' cases between scenario work and planning • Use case discussions to bridge a gap of understanding between novices and experts • Use writing case analysis to personalize an understanding of the experts' cases in learners' words
Designing the structure of CBD activities	• Identify the characteristics of the authentic tasks as a unit of CBD for a particular domain in terms of importance, difficulty, time, and cost • Allow multiple tasks and order the tasks, if possible, from simple and easy to complex and difficult • Provide a Web- or computer-based activity support tool and make it explicitly connected to learners' tasks • Determine additional ways of supporting learners' activities, such as explanation, demonstration, monitoring, coaching, expectation failures, feedback, and resources with and without Web or computer technology. • Include a chance to use experts' cases to accomplish learners' tasks: Make learners understand and how why they use experts' case libraries as advice and as resources for their tasks
Participating in social practices	• Help learners to be motivated to participate in social practices • Design several different levels of social practices, including peer feedback, peer work, group discussion or work, instructor feedback or instructor-led discussion, and interaction with virtual experts by case analysis
Developing learners' case libraries	• Make learners' reflection stories (i.e., cases), including contextual information, lessons, and possible solutions for the future, concrete processes of accomplishing their tasks, and keywords for indexes • Encourage learners to share their cases with others through feedback with peers, Web publishing, and advice letters to other novices in relevant situations

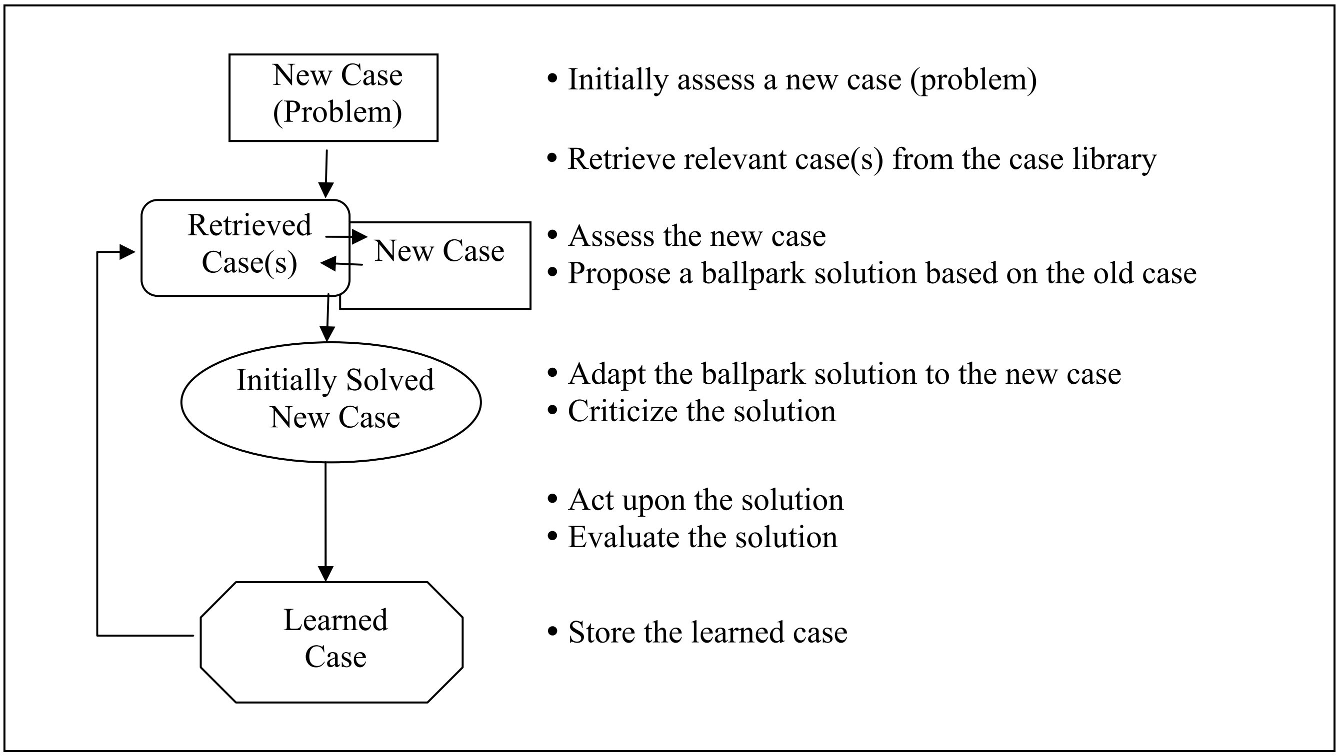

Figure 2.1. Case-based reasoning (CBR) process.

Note. Adapted from Aamodt & Plaza, 1994; Kolodner, 1993.

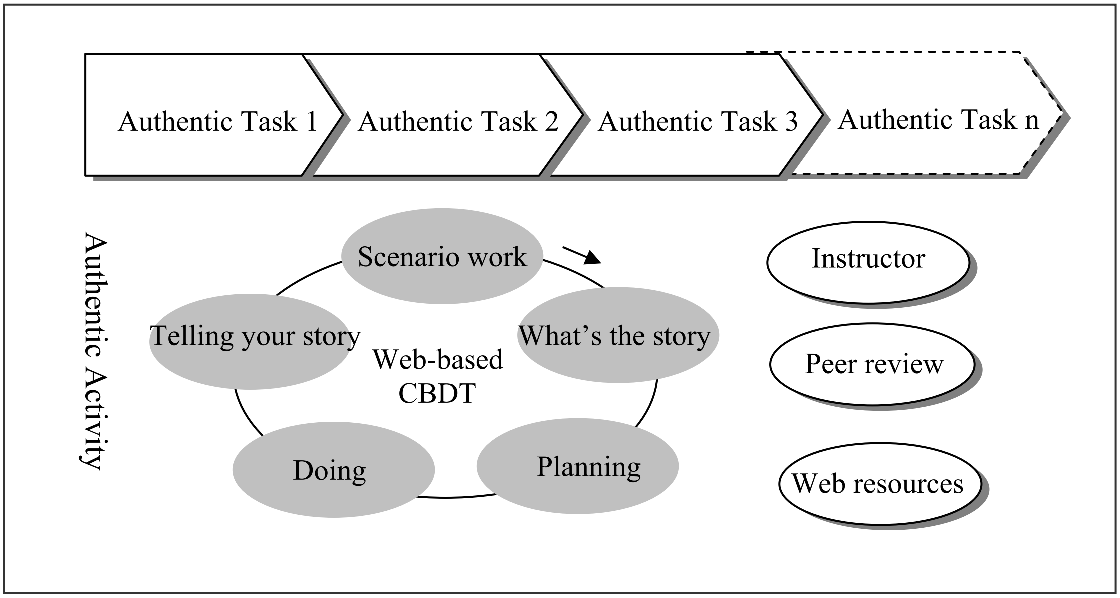

Figure 2.2. The structure of case-based doing (CBD).

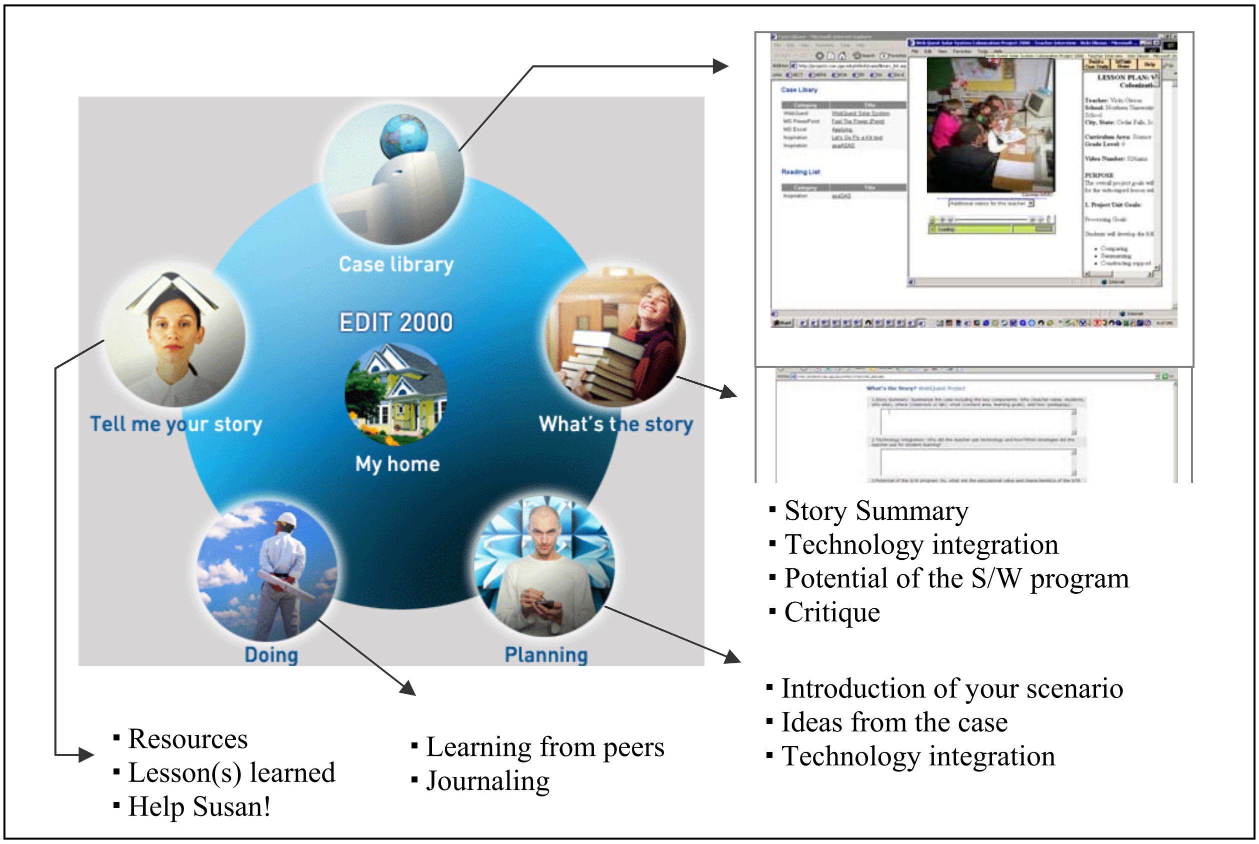

Figure 2.3. The screen shot and template structure of the Web-based case-based doing tool (CBDT).

CHAPTER 3

LEARNING TO TEACH WITH TECHNOLOGY: DEVELOPING SITUATED KNOWLEDGE VIA WEB-ENHANCED CASE-BASED REASONING[3]

[3] Kim, H., & Hannafin, M. J. To be submitted to *American Educational Research Journal*

Abstract

Preparing preservice teachers to integrate computers into everyday classroom practice has proven problematic. Preservice teachers often lack the situated knowledge, rooted in everyday classroom experience, needed to recognize and evaluate technology's potential to support teaching and learning. This study examines how preservice teachers gain situated knowledge about teaching with technology by engaging the experiences of practicing teachers through Web-enhanced case-based reasoning. Changes in preservice teachers' perceptions and understanding of educational roles of computers and critical concepts in situations were documented over the course of a semester. Web-enhanced activities helped majority of preservice teachers to both understand and develop appropriate uses and influenced their perspectives for teaching with technology to evolve.

During the past decade, educators and researchers have underscored the importance of preparing preservice teachers to integrate computers into their teaching practices (Office of Technology Assessment (OTA), 1995; Russell, Bebell, O'Dwyer, & O'Connor, 2003; Willis, Thompson, & Sadera, 1999). Although the "best way" to prepare preservice teachers remains elusive, there exists widespread consensus that teacher education programs need to promote meaningful technology integration skills in the future teacher workforce, and not simply promote mastery of isolated computer skills and applications (Beyerbach, Walsh, & Vannatta, 2001; Brownell, 1997; Gibson & Hart, 1997; Gillingham & Topper, 1999; Hargrave & Hsu, 2000).

This goal, however, has proven difficult to attain. Preservice teachers lack the firsthand experience needed to recognize and implement promising technology integration practices in their classrooms (OTA, 1995). Consequently, they engage in preparatory coursework with limited understanding of the relevance or appropriateness of classroom integration content and methods. In addition, individual preservice education students have not yet entered the professional community of practice where experiences, insights, and strategies are shared among experienced teachers (Putnam & Borko, 2000). In contrast to practicing teachers, preservice teachers collectively lack applied teaching experience, limiting the quality, breadth, and depth of available perspectives. Paradoxically, Russell et al.'s study (2003) indicated that although new teachers reported greater confidence in their computer skills than did experienced teachers, the new teachers initially integrated computers less often. They concluded by reinforcing a key assumption of situated learning for teaching with technology: Teachers must understand both the culture of teaching and the pedagogical value of technology. Teacher knowledge is considered situated, constructed from and refined through repeated teaching experiences (Carter, 1990).

According to situated learning perspective, learning and acting are inseparable, and experience is provided through authentic activities (Brown, Collins, & Duguid, 1989). Recent work in case-based reasoning (CBR) reinforces the importance of authentic activity for situated learning (Kolodner & Guzdial, 2000; Kolodner, Owensby, & Guzdial, 2004; Schank, 1993/1994) and may help to bridge experience and knowledge gaps between practicing and preservice teachers. Cased-based reasoning approaches generally include ill-structured, authentic tasks, activities, and decision points, as well as experts' reasoning as embodied in exemplary cases. Case representations of expert teacher experiences may help to situate such learning for preservice teachers, providing access to insights and practices for the community and enabling novices to engage advanced, non-trivial experiences and challenges otherwise beyond their reach.

By engaging these experiences, novices may gain socially shared meanings of concepts, skills, and identities (Brown et al., 1989). Kim and Hannafin (2005) proposed a Web-enhanced CBR framework that allows inexperienced teachers to engage everyday teaching practices. Conceptual case knowledge presents "context-dependent" (Brown et al., 1989, p. 32) concepts and facts. When such knowledge becomes situated, it is better used and understood within the associated community (Collins, Brown, & Newman, 1989). Expert case knowledge includes conceptual situations in the form of stories (Lave & Wenger, 1991), which are indexed and interwoven into various situations. As novices gain experience, their representations become richer, eventually enabling them to build collections of their own case knowledge—that is, a personal *case library* (Kolodner, 1993,

p. 141). For example, teacher knowledge typically focuses on knowledge of students, curriculum, content, and pedagogy (Leinhardt & Greeno, 1986; Shulman, 1986). Fisher (1997) noted that experienced teachers identified the competencies of teaching with technology, including basic technology skills and the integration of them into curriculum and instructional strategies. An expert teacher may use flow-charting software to teach 10^{th} graders concept mapping and brainstorming the themes of a poem. These experiences are compiled and indexicalized as conceptual case knowledge in the teacher's individual case library, where it can be accessed, applied, and modified when needed in the future. Unlike the preservice teacher, the experienced teacher's situated knowledge is continually refined, not limited to technological or procedural facility, and can be applied as a tool to support different activities under various circumstances.

Identity and beliefs also develop during the enculturation process (Brown et al., 1989; Lave & Wenger, 1991). To develop identity, novices negotiate meaning in order to better participate in the social practices of a community. Members in a teaching community do not simply reproduce socially-shared meaning through participation in social practices and activities—they also change them: "The generality of any form of knowledge always lies in the power to renegotiate the meaning of the past and future in constructing the meaning of present circumstances" (Lave & Wenger, 1991, p. 34). Exemplary teachers, for example, often report constructivist-inspired, student-centered pedagogical beliefs; therefore, they characterize their role as facilitator, collaborator, and co-learner with their students (Becker, 1994; Becker & Ravitz, 1999; Ertmer, Ross, & Gopalakrishnan, 2000). Consistent with these beliefs, exemplary teachers tend to employ collaboration, research-based inquiry, hands-on activities, and publishing in their practices.

Despite widespread advocacy in teacher education (Putnam & Borko, 1997), research on teacher learning using situated learning pedagogies remains rare. Although studies have been conducted to examine how and why inservice teachers use computers (e.g., Wallace, 2004; Windschitl & Sahl, 2002), few have focused on preservice teachers to refine their knowledge. The purpose of this research was to examine if, and how, situated knowledge changed through Web-enhanced CBR. As Kim and Hannafin's (2005) framework indicates, expert teachers' situated knowledge for teaching with technology can be elaborated in conceptual case knowledge and beliefs. The situated knowledge may include beliefs about computers' educational roles and conceptual understanding about the practices for teaching with technology. Accordingly, two research questions guided this study:

1. How does understanding about the educational roles of computers change through Web-enhanced CBR?
2. How does understanding about teaching with technology develop during Web-enhanced CBR?

Method

Design

We employed a multiple case study approwwach in order to deeply understand the phenomenon, the process, the perspectives of the people involved, and the combination of each (Merriam, 2002). A case was defined as each preservice teacher's perspective on and understanding of teaching with technology in a Web-enhanced CBR course, which is a phenomenon in a bounded context (Miles & Huberman, 1994).

Participants

Of the 18 undergraduate enrollees, 7 preservice teachers were initially identified: 2 reported both teaching and lesson planning experience, 2 reported only teaching experience, and 3 had neither teaching nor lesson planning experience. None reported experience teaching with technology. We collected data on all 7 preservice teachers and selected 5 participants for in-depth data analysis based on the amount and quality of information. We also mixed the diversity of sampling with respect to their grades, majors, prior experience, initial technical skills, and understanding of technology integration. Maximum variation sampling was used to find various cases in a reliable way (Glaser & Strauss, 1967).

Accordingly, we selected 5 of 7 preservice teachers. We did not select 2 preservice teachers, Erin and Carol, because their interview data were not informative and because they were similar to other participants in key respects they already represented. Erin, a 3rd-year student in English education, was compatible with Liz in that they both self-reported a high level of technology skills in the beginning of the semester and had relatively rich teaching and lesson planning experiences. Carol was similar to Stephanie with respect to grade level and lack of prior teaching and lesson planning experiences. Stephanie was finally selected because they both had initially self-reported a high level of technology skills and majored, or planned to major, in the same academic area. Individual summaries from the student information sheet and the first interview are shown in Appendix A.

Cindy, a 21-year old European American female, was a junior in Early Childhood Education. While she had comparatively rich experience and confidence in both teaching and lesson planning, she perceived her computer skills as being low. Cindy was required to take this course, and her initial learning goal for the course focused on a mastery of various computer programs. During the study, she worked on projects for 3rd grade social studies and science education courses. Cindy perceived confidence in her ability to develop technology-enhanced lessons and instructional materials and focused on new ways of teaching with technology. While she did not report difficulty learning to use software programs, she reported that the development of technology-based materials, such as the PowerPoint Game and WebQuest, was time-consuming.

Liz, a 21-year old European- American female, was a senior in Middle School Education. She had teaching and lesson planning experiences from prior coursework. She was required to take this course, and her initial learning goal for this course was to become “computer savvy.” Liz worked on course projects related to language arts and geography for middle school students. In all of her CBR projects, she indicated confidence in her ability to develop lessons and use software programs and focused on the details of instructional materials, such as pictures and color.

Alex, a 19-year old European American female, was a sophomore planning to major in Special Education. Previously, she spent considerable time observing her mother’s and her aunt’s classrooms. Alex had also previously worked as a substitute teacher, but had no experience in lesson planning. She recounted that she had few expectations for this course, except to be “more informed about technology.” During the course, Alex developed lesson plans and materials for language arts, mathematics, and social studies for elementary resource students. While she did not feel that the computer programs were difficult to learn or use, she experienced difficulty creating detailed aspects of lessons, such as student activities and directions.

Carrie, a 20-year old European American female, was a sophomore who planned to major in Special Education. She had neither teaching nor lesson planning experience, except for volunteering in a camp the previous summer and observing a K-12 class during the current semester. Carrie's initial goal focused on learning computer programs. She worked on course projects related to social studies for middle and high school students. During the course, Carrie perceived difficult both in using computers and in developing lesson plans and materials; however, the course project provided a gateway for her to learn teachers' practices.

Stephanie, a 20-year old European American female, was a first-semester junior in Early Childhood Education, having recently transferred from another college. Over a three-year period, Stephanie had occasionally worked as a volunteer in her mother's classrooms, but she had no experience in teaching and lesson development. Her initial learning goals for this course were to master computer skills and to learn how to use them in her classroom. Stephanie's projects focused on 3rd grade social studies. Stephanie did not report difficulty in developing lesson plans or using computer programs and focused on production of course projects.

Research Setting: A Web-enhanced Case-based Reasoning Course

The course was an introductory technology integration course for preservice teachers offered in the College of Education of a large Southeastern university during the fall semester of 2004. According to the course syllabus, the focuses of the course were "learning to create teaching and learning environments using technology" and "design[ing] and creat[ing] products for learning environments through numerous activities with various technologies." The course was organized in terms of software programs (e.g., Inspiration, Microsoft Office) and featured project requirements that involved software programs (Appendix B).

All enrollees were involved in both CBR and non-CBR units and requirements as part of their coursework. Because this course was designed for preservice teachers, all students were asked to develop lesson plans and teaching materials for technology use in classroom contexts. The non-CBR units consisted of the instructor's introduction of a new project and demonstration of software programs, followed by preservice teachers' material development. The course assignments included sending an email with an attachment to the instructor; using Microsoft Office to develop newsletters, seating charts, and business cards; searching for examples of lesson plans using Georgia Learning Connection (GLC) Websites; and developing the initial frame of their e-portfolio Websites with Dreamweaver software. The present research focused on the CBR units.

Web-enhanced case-based reasoning (CBR). Using Kim and Hannafin's model (2005), we designed Web-enhanced CBR units for preservice teachers to experience ordinary practice related *CBR* to teaching with technology (see Appendix C) during 10 weeks of the 16-week course. The CBR units focused on preservice teachers' development of lesson plans and instructional materials for teaching with technology. Three authentic technology integration tasks were distributed throughout the course, followed by a culminating microteaching synthesis activity. As illustrated in Appendix C, the CBR cycle was enacted by introducing a novel case (scenario work), accessing analogous cases using learners' own case knowledge or that provided by an expert teacher (case analysis), attempting to interpret and analyze the new case and proposing preliminary solutions (planning), adapting and applying the case (doing), and reflecting on new case knowledge (reflection). Throughout the process, the instructor provided ongoing coaching and feedback, peer feedback was available, and a wide array of Web resources was provided.

The course projects for the CBR units included Inspiration, a PowerPoint game, and a WebQuest. Inspiration was selected for the first unit because of both the simplicity of the technology and of the project itself. The final products for the Inspiration unit included a lesson plan describing the computer application use in teaching or learning, as well as application-generated instructional materials (e.g., worksheets) (see Appendix D for sample Inspiration materials). During the second project, preservice teachers developed a PowerPoint game as an instructional material for a particular lesson context. The final products of the PowerPoint game project included the PowerPoint game and game board in an electronic or printed format (see Appendix E for an example). The WebQuest project, which involved creating a Web-based lesson plan, as well as other material in a structured format, including the introduction of the project and information regarding the learners, tasks, process, evaluation, and conclusion (see Appendix F). In both the PowerPoint game and the WebQuest project, additional lesson plans were not included because the projects focused more on activities than simple worksheets or instructional materials. However, the preservice teachers were asked to address the lesson context, such as grade, subject matter, learning activity, and the role of the PowerPoint game or WebQuest in a whole unit. A 15-minute microteaching session using one of the CBR course projects was also included for practicing implementation.

Web-enhanced case-based doing tool (CBDT). Figure 3.1 illustrates the Web-based case-based doing tool developed to support CBR activities (Appendix G contains a copy of the manual). The CBDT consists of a case library and CBR scaffolds. The case library served as a repository for experts' exemplary cases about their practices so that novices could learn from experts' experiences and use the cases as advice for relevant tasks (Kolodner et al., 2004). Three video cases featuring approaches to Integrating New Technologies Into the Methods of Education (Grabe & Grabe, 2001) were provided, during which experts provided exemplars (including sample lesson plans) of teachers using computers in K-12 contexts. Cases from the Knowledge Innovation for Technology in Education Project (Wang, Moore, Wedman, & Shyu, 2003) were also provided to assist preservice teachers as they sought additional information or examples. Case-based reasoning scaffolds were available in the form of templates during each technology task to facilitate reflective thinking. Preservice teachers were able to write in the templates, which provided guiding questions.

During CBR units, the instructor introduced the basic concepts and application samples for a given software application (e.g., instructional materials using the PowerPoint game) and course projects (e.g., its purpose and scope). Preservice teachers then decided on individual course projects, including content area, grade, and a rough context, and received feedback from the instructor. Next, the instructor introduced a relevant video case from the case library, explaining critical concepts (e.g., role of technology, learning goals) and providing guiding questions (e.g., "How did the teacher help preservice teachers while they developed their PowerPoint games?") in the CBDT, as participants watched the case in class. After watching the case, the instructor facilitated whole-class discussion about the expert teacher's computer use within (but not limited to) the given categories. Preservice teachers also wrote the case analysis using the CBDT template (i.e., *what's the story*).

During planning, preservice teachers initially constructed their ideas before developing the details of the lessons and materials. Preservice teachers generally utilized Websites and textbooks to find curriculum standards, teaching ideas, and other resources. They were also asked to write the applicable ideas from the teacher's case by comparing and contrasting the case with their own projects. The preservice teachers also had a chance to identify the role of computers in their project as part of planning. They wrote their initial plan using the *planning* template in the CBDT. The preservice teachers revised and clarified their scenarios, if necessary. In the doing phase, preservice teachers developed lesson plans and teaching materials using unit-specific software (e.g., concept maps using Inspiration or game materials using PowerPoint). During this phase, they participated in a feedback session from their peers and discussed unexpected issues that may occur while implementing their lessons. Preservice teachers wrote journals using CBDT's *doing* template.

At the end of each unit, preservice teachers documented their reflections using the *tell me your story* template, integrating their perceptions and experiences on this project through their own story constructed through their experience. As part of the *tell me your story* template, they also used the tool to write a letter of advice to Ms. Susan Jones, a virtual beginner teacher who indicated willingness to use technology, particularly for a course project, but noted that it was difficult to do so. Preservice teachers were given the printed letter from Susan as a handout in class (Appendix I) and wrote the reply letter via CBDT. Finally, each preservice teacher generated a CBD report printed from the CBDT and submitted the report along with his or her lesson plan and materials to the instructor (Appendix H).

Data Sources

The major data sources in this study included in-depth qualitative interviews with preservice teachers, CBD reports, and lesson plans and materials for computer use produced by the five participants (Appendix J). In addition, memos from ongoing conversations with the instructor, other course materials, video recordings of microteaching sessions, and field notes from class observations were collected to supplement the main data.

Interview protocols. Interviews with the students were conducted at the beginning, middle, and end of the semester; an instructor interview was also conducted at the end of the course. Three interview protocols for preservice teachers are provided in Appendix K. The first interview focused on (a) background and experience, (b) beliefs about learning, teaching, and teaching with technology, and (c) initial understanding of teaching with technology. The second and final interviews probed (a) preservice teachers' perspectives on and understanding of teaching with technology and (b) perception and use of the Web-enhanced CBR activities. All interviews were semi-structured and lasted between 30 and 60 minutes. All of the interviews were tape-recorded and transcribed. The instructor's interview was used to triangulate the evidence on preservice teachers' development of knowledge about and perceptions on teaching with technology.

Archival documents. Archival data consisted of the participants' three CBD reports and assignment artifacts (e.g., lesson plans and instructional materials). The CBD reports were hard copies printed out from preservice teachers' writings in the Web-based CBDT, consisting of (a) *what's the story* (i.e., case analysis), (b) *planning*, (c) *doing*, and (d) *tell me your story* (i.e., reflection). Assignment artifacts consisted of Inspiration lesson plans and worksheets, PowerPoint games, WebQuest lesson materials, microteaching written feedback, microteaching reflections, e-portfolios, written feedback from peer reviews, and other assignments. The archival data were used as important evidence regarding the evolution and depth of preservice teachers' situated knowledge.

Procedures

As outlined in Appendix L, the current study was implemented over the course of a 16-week semester. Weeks 1-5 consisted of an introduction to the course and an orientation to the research study. The first class meeting proceeded routinely, emphasizing non-CBR units and activities. The instructor introduced this study's first author and the research study. The first author was identified as a researcher and a technical assistant who had no influence over students' grades. During week 3, the instructor and the first author explained the details of the study and recruited participants, collecting and analyzing information sheets and course artifacts of the course along with observation notes. The results provided the background for participants' preliminary interviews, which were conducted two weeks before the CBR units were introduced. In order to chronicle the development of the preservice teachers' understanding resulting from the CBR learning activities and non-CBR course projects, a preliminary interview was conducted prior to the CBR units during weeks 4 and 5.

The first Web-enhanced CBR activity, focusing on Inspiration, was implemented during weeks 6 and 7. The instructor introduced the CBR activity and demonstrated how to use the CBDT, showing the learners how to write in the CBDT and how to download the trial version of Inspiration. Most of the students who used CBDT did so without significant problems, as the structure of CBDT was pilot tested and refined as part of the pilot study.

Participants wrote in CBDT mostly in class. They occasionally watched teacher video cases multiple times to write their case analyses in the *what's the story* section in CBDT. After case analysis, they were encouraged to use CBDT before activity to brainstorm and after activity to reflect. The first author also provided technical help when the participants needed it. Because the preservice teachers' task was to develop instructional materials (e.g., teacher's handout or student's work sample) and the lesson plan, lesson plan templates were provided to support development and to standardized lesson plan formats.

For peer feedback, the instructor paired off preservice teachers to approximate the community to the maximum extent (Lave & Wenger, 1991). Because an odd number of preservice students were enrolled, one participant was paired with the exchange student who was also an education major.

During weeks 8-10, the PowerPoint unit began with the introduction of instructional games by the instructor to motivate preservice teachers to develop their own games. The preservice teachers then followed the sequence of the CBR activity, which included writing their game scenarios, watching and analyzing the teacher's case, planning and developing their games in PowerPoint, and reflecting on their practice. All enrolled students used CBDT in the same way with during the first Inspiration Project. None of the students showed difficulty in using CBDT. The instructor also demonstrated the advanced functions of PowerPoint, such as the use of sound, animations, and clip art, before learners began developing the details of their game. En-route interviews were conducted between weeks 8 and 10, along with collecting CBD reports, artifacts, peer feedback sheets, field notes, and course materials.

During week 11, all students participated in a unit focusing on accessing and using Web resources in constructing lesson plans. This unit provided the Web familiarity and foundation skills needed for the WebQuest project, which involved creating Web-based lesson plans, and guided participants in the identification and selection of material in a structured format, including the introduction of the project and information regarding the learners, tasks, process, evaluation, and conclusion.

The WebQuest unit, conducted during weeks 12-14, began with an introduction, examples, and templates on the WebQuest website. Preservice teachers initially created a context for their WebQuest and then studied the teacher's WebQuest case in the CBDT. All students in the course used CBDT without particular problems. In the CBDT, they wrote their case analyses and elaborated their initial plans per the WebQuest template. They generally began by writing in the *Introduction* section and finding instructional websites. During the WebQuest component of the class, the first author observed participants' activities in class and collected artifacts such as peer feedback sheets, printed WebQuests, and CBD reports.

During weeks 15 and 16, pairs of preservice teachers presented 15-minute, technology-enhanced microteaching lessons to their classmates and instructor using one of their course projects (i.e., Inspiration, PowerPoint game, or WebQuest). Each microteaching session was videotaped so that presenters could monitor them later to facilitate their reflections on the activity. Following the presentations, the instructor and class members provided written feedback to the presenters. The instructor scaffolded preservice teacher performance by directing, demonstrating, modeling, monitoring, and coaching through the CBR process. Peer review supported the exchange of feedback for lesson plans and materials, while Web resources enabled preservice teachers to align their lessons with curriculum standards and to use diverse examples of technology-enhanced lessons.

At the end of the semester, individual students also completed the e-portfolio websites by compiling all of their course projects and reflections. The participants' written reflections on the e-portfolio were used as evidence for their comprehensive understanding of teaching with technology.

Final interviews were initiated during the microteaching sessions and were completed within 4 weeks after the course ended. The first author conducted all but one of the final interviews within two weeks of the course's completion; due to an unanticipated lack of availability, the remaining interview was conducted in the fourth week after the course's completion. At the end of the semester, the instructor was interviewed to determine her perception of students' learning and the effectiveness of the CBR activities. Preservice teachers' final CBD reports, course artifacts, field notes, and microteaching video tapes were also collected in the final phase.

Analysis

In order to ground findings in the data and to make major categories by comparing the five cases, data analysis followed the constant comparative method (Strauss & Corbin, 1998) and consisted of open coding, constantly comparing emerging themes and refining categories. For open coding, the researcher coded the majority of the data using the Atlas.ti 4.2 software program. The *microanalysis* method (Strauss & Corbin, 1998, p. 57), or line-by-line analysis, was adopted initially to create tentative categories by case and to identify detailed characteristics of those categories. Open coding resulted in a number of codes, which were grouped according to themes. For example, “easier search,” “effective presentation,” and “report writing” were grouped under the theme “computer use for productivity”; “computer for interesting learning,” “computer for attention,” and “multimedia for appealing” were grouped under “computer use for motivation.” These groups were classified into the larger category “the purpose of computer use.” As a result, a list of the tentative categories and subcategories was created for each case.

Data analysis for the second case was not conducted until the list of the codes for the first case had been made such that categories about individual learning as a unit of each case could be identified. The second case was analyzed by constantly comparing results to results from the first case, and emerging new categories and subcategories were added to the list of tentative categories. After creating tentative categories for each of the five cases, the researcher created an integrated list of the initial categories, subcategories, and descriptions emerging from the data (Appendix M), which was then used for final category formation. After analyzing and comparing the five cases based on the coding scheme, the researcher noted patterns based on research questions.

Validity and Trustworthiness

Consistent with Merriam’s (2002) strategies for promoting validity and reliability, this report includes a thick description of the context of the study, a detailed account of the process of data collection and analysis, triangulation through multiple data sources (Denzin, 1970), and maximum variation via diversity in purposeful sampling. Peer checking with two other researchers was employed to promote reliability and to obtain consensus for open codes and tentative categories from the data analysis for each of the five cases.

Findings and Discussion

How does understanding about the educational roles of computers change through Web-enhanced CBR?

Prior to course projects, the participants had basic views about computers' educational roles, mostly as motivational and productive roles. During the early course activities, their technology experience was largely consistent with their initial perceptions. As they were engaged in increasingly situated CBR activities, they began to identify computers' various roles to help students learn content and thinking skills (Appendix N).

Perceived simple roles. Participants' initial perceptions were primarily based on recollections of their K-12 experiences as students and their opinions on computers' roles in education. All participants initially identified one or two computer roles to one or two images, most commonly productivity and motivation. All but Carrie perceived the major role of computers for education as increasing productivity. Cindy had used computers in school since pre-school for computer games, PowerPoint presentations, Word processing, and Internet research. She also observed many teachers' use of computers for PowerPoint presentations and Internet searches. Regarding Internet searching during her K-12 education, Cindy stated, "We didn't use the textbooks that much because we found a lot of stuff online."

Liz mentioned that computers are "A lot faster and a lot easier and to me, it is simple to understand." She had not used computers often to learn subject matter as a K-12 student; instead, she took varied computer courses, ranging from computer literacy to using spreadsheets (Excel). Likewise, Alex perceived computer use as an "easy" and "fun" way to learn, drawing from her K-12 experience as a student and her perspectives on teaching with technology. She reported that she used computers in high school labs to “do research online” during English or social studies classes, noting that computers made it “…a lot easier to get your resources on the Internet instead of going to the library.” She also stated that technology integration “…is just like learning how to use the computers to your benefit and like the easiest way to do stuff using a computer.”

The computer’s motivational value was noted by all participants but Cindy. PowerPoint multimedia presentations, for example, were thought to increase student attention to the teachers, while online searching provided alternatives to searching for information in a book:

> Usually the computer is fun, you don’t have to sit there and answer questions or read out loud, really boring. And I had just been like human nature, like getting excited about a change…. (Alex’s first interview)

In contrast, Cindy was the only participant who initially did not view computers as motivating for students and who stated that computers might limit students’ creativity, hands-on activities, and interactions with the teacher: “I don’t want children to have to do everything online or on the computer, and they never get to use their hands other than just typing stuff.”

Carrie considered computer-supported lessons as a motivational way to teach: “It’s just a different way to do things.” She recounted that, compared to other classmates, she had not used computers much in her K-12 classes. On the other hand, Stephanie reported many K-12 learning experiences with computers, including presentations, searches for Web resources, movies, and word processing; during college, she also learned Microsoft Office for her coursework. Her initial technology integration perspectives reflected her memories:

"I pretty much see it as like bringing in the computers and different hi-tech movie things." Stephanie seemed to believe that mathematics is not as appropriate a subject for the use of computers as is history. History teachers, she indicated, implemented different projects and taught languages by using different motives and games. Stephanie stated that computer use helps students to "pay attention."

None of the participants initially perceived that computers could play an important role in student learning and everyday classroom teaching. Rather, all perceived technology experiences as separate from normal practices for teaching and learning, describing technology's role as providing an "extra boost" or a "supplement." In her initial descriptions of technology integration, Carrie identified lecturing as the primary pedagogy and computers as supplementary: "I think that is what it can really be good for, and then just emphasizing what you are already teaching." According to Cindy, although computer labs were also used during some classes to search for online resources, these were not considered normal lessons. She used computers during her own K-12 experiences, but perceived that computers were not central to her lesson planning as a teacher, describing computer-based lab lessons with terms such as "side," "extra," and "special thing":

> A lot of my teachers used PowerPoint, and then we did like in chemistry, we used a lot of technology, like going online and looking up chemicals and stuff. But I wouldn't say it was my main form of being taught with; it was a side, an extra, or a special thing. (Cindy's first interview)

When participants initially described computers as supplementary, they often compared them to other traditional classroom components. Cindy, for example, stated that computers were used instead of the "blackboard," "poster board," and "textbook." In high school, she used PowerPoint as “a poster board” for easier and better organized presentations. Likewise, Liz equated computers with chalkboards and overhead projectors as a presentation tool for teachers and a resource tool for students.

> The only times I can really remember my teachers using something to teach with would be if they were showing us how to do something, like how to do a project and if we needed to use a search engine on the computer, like in the library to go and look at that. That is really all I can remember teachers using computers. Mainly, it was the chalkboard or the dry erase, like later in 12^{th} grade, and overhead projector was the main thing that we used. (Liz’s first interview)

Emergent understanding of technology’s roles. During the Inspiration and PowerPoint units, participants both continued to perceive computers as supporting simple roles and used computers accordingly. Participants considered and used Inspiration primarily as a tool for improving productivity, motivation, or both. For the first Inspiration project, Cindy created the lesson for Web-based research and used Inspiration to present the research project with links to Websites. Although the lesson employed research as the main pedagogy, Inspiration was used *to deliver* a presentation about the research-based lesson rather than as a learning tool. Liz used Inspiration to make a teacher’s handout for the lesson. In her case analysis, she described Inspiration’s role as that of a learning tool, helping students’ “knowledge of the story by having them each write sentences about tornado safety” and improving students’ “typing skills and sentence structure skills.” In her project, however, Liz used Inspiration to produce a teacher’s handout featuring blank bubbles. She wrote in her lesson plan that student pairs would use “pre-made Inspiration worksheets,” indicating that Inspiration was used as a productivity tool in her lesson.

Interestingly, while Carrie, Alex, and Stephanie used Inspiration as a learning tool to help students learn specific concepts, they continued to describe Inspiration's ability to create webs as an efficient and motivational alternative to drawing a paper-based web. When advising a virtual new teacher how to use the application, Alex described Inspiration as a student productivity tool rather than as a tool to contribute to meaningful learning. She noted that using software to create a concept map was as efficient as creating the same concept map using paper, but wrote in her lesson plan that she used Inspiration for "pre-writing skills." Rather than making a class trip to the computer lab, creating the webs could be part of a center.

> First, each group would make some plans for their web, on paper. As groups finished their plans, they could take turns creating their webs using the computer. This way their time on the computer would be used strictly for production, rather than trying to generate ideas as well (Alex's Inspiration CBD report).

During her projects, Alex began to identify some extended roles for developing student thinking skills. In her case analysis, she noted that Inspiration gives students "another way to organize their thoughts [that] aides the students in their pre-reading skills." Despite video cases focusing on students developing PowerPoint games, Alex's PowerPoint case analysis described how she focused on the educational roles of computers for enhancing students' skills and self-learning. She reflected that a new computer use "point of view" began to emerge related to teaching as well as "a more positive outlook" on teaching with technology.

In the first Inspiration project, Carrie maintained the perspective that computer use was supplemental to the lesson. In her case analysis, she noted that the teacher used computers to organize students' ideas, but identified computers as "a visual aid." Carrie described her Inspiration project as an example of a "pre-writing assignment using Inspiration: how to develop a political platform." Her PowerPoint project, however, demonstrated emergent understanding of technology's motivation role. In her case analysis, she stated that student-developed games help them to learn concepts, spelling, and collaboration. Since she developed the game for the teacher to present, the role of the game focused on students' motivation for learning.

> Using the computer always seems to excite kids, so that will help them become interested in the game. Also there is a lot you can use on PowerPoint, such as noise and moving objects that keep the kids engaged. (Carrie's PowerPoint game CBD report)

Stephanie maintained her perspectives on computer use for students' motivation and efficiency in the Inspiration and PowerPoint units. She used Kidspiration, a type of Inspiration for younger children, as a learning tool to help students make a concept map of the community. She considered Kidspiration to be an easy and interesting way to facilitate learning: "…it helps make things more exciting, your kids are motivated and they are excited and it will be easier to remember more if they are not bored." In her case analysis, she frequently documented Inspiration use for productivity and motivation: "She also used the webbing tool, and Microsoft Word to help keep the lesson exciting, and to bring interest to the subject" and "it helps them to see how handy it is to web." Commenting on her PowerPoint unit, Stephanie stated, "I will use the software to help make learning states and capitals more enjoyable. It will also make it interesting, and the children will have motivation to learn."

Interestingly, while their course projects demonstrated the emergence of technology integration, participants continued to describe computer use as being supplementary to regular teaching and to equate computers with traditional methods. For example, Carrie described her Inspiration lesson as “an extension or practice of what students should have already learned.” She reflected, “I am not certain how useful Inspiration is in the long run, because I feel fully capable of drawing a concept map on a board.” PowerPoint games were designed to *review* what had already been learned via question-and-answer format. For example, Cindy used the PowerPoint game to *review* the content, the characteristics of Native Americans in social studies, in a more interactive and interesting way. Liz’s game provided a “review” after reading: “Based on a review sheet handed out in class after the book was completed- the students should be well prepared to play the game.” Although she acknowledged other roles, such as facilitating presentations and making seating charts, Carrie characterized her game as a review to follow a lecture, describing PowerPoint as “another extra tool.”

Acquired potential for diverse roles. As preservice teachers encountered different programs and lessons, they expanded their assessments of technology’s purpose and value. By the end of the semester, participants also identified multiple roles of computers for providing interaction, encouraging learner ownership, and facilitating the learning of content and thinking skills. The purpose of computer use for learning both concepts and thinking skills was evident across participants. In the WebQuest project, Cindy used computers to enhance student achievements, encouraging thinking skills, and providing an interesting learning opportunity. In her case analysis, she observed that computers contributed to student learning in various areas:

> This assignment is also more than just learning about the solar system—it is forcing the students to use their reasoning and deductive skills to answer important questions. It also makes them aware of the specialized position of whichever task they choose. This is a very interesting and interactive way to teach about the solar system, and it seems that the students are really engaged. (Cindy's WebQuest CBD report)

Cindy also eventually identified technology's motivational potential not apparent initially. She noted that computers could add value to her teaching: "I think that technology should be something that you learn and also something that can motivate you to learn because kids like working on it."

In her case analysis, Liz indicated that WebQuests help students in "individual/peer learning…to research and produce their own work…work[ing] together…[and becoming] responsible." Liz also identified WebQuest's potential as a learning tool for her virtual students in her CBD report: "This program will be used to help the students to research and develop a project that is filled with information and learning experiences for the student."

In Alex's case analysis, she considered WebQuests as "learning tools" for "doing research" in a "creative" way. She repeatedly mentioned the WebQuest's educational value in allowing students to learn in real-life situations. In her CBD *planning* template, she wrote: "WebQuest will open their eyes to some of the experiences that the actual settlers had." Alex added that computers may facilitate communication among teachers, parents, and students, noting specifically that teachers' Web pages would help them better communicate with parents.

Stephanie's perspectives on computer use also expanded. For example, in her case analysis, she addressed the teacher's idea of using WebQuests for motivation, learning concepts, and learning thinking skills through Web resources and role playing. Her WebQuest project provided a model for student motivation and a quick, effective way to learn. Stephanie's final definition of technology integration extended beyond computers, but her perception of the purpose of computer use included both motivation and learning:

> Just like incorporating any kind of technology into learning in general. Like television, projector screen, just anything instead of standing in front of a class and lecture and give out worksheets. Making it more fun and interactive. You learn more and not just watch somebody talk to you. (Stephanie's third interview)

In contrast, Carrie did not significantly change her perspective, continuing to focus on motivating and supplementing regular instruction. In her case analysis, she stated that the benefits of a WebQuest are mostly to motivate students and to provide "much more up-to-date information when using the Internet" than textbooks, and using websites the teacher already found. During the final interview, she stated that WebQuests are used to motivate, to do research, and to learn thinking skills. Monitoring of websites by teachers was the best benefit gained from WebQuest use, noting:

> I learned that you could have students go in and use like the Internet and an easy way where you could be monitoring more or less what they were doing so they could only go to those specific sites and I think that was a helpful thing. (Carrie's third interview)

Regarding importance, 3 of 5 participants' perspectives on computers, except for Carrie's and Stephanie's, evolved from seeing the computers as being simply supplementary to seeing them as being helpful for learning. Cindy noted that computers could help teachers to enhance students' learning capabilities, and not simply to replace teacher roles. Liz indicated that computers should be used for everyday learning, emphasizing their potential to increase motivation and support individual differences. Alex recognized the important role of computers for student learning, writing in her case analysis that "they [students] were able to learn a lot more than just simple facts about planets" and that "they always respond well to projects that involve computers as learning tools." During the final interview, Alex indicated that computers could support regular classroom instruction and that teachers should balance their use with lesson plans that do not emphasize computer use. She also acknowledged unique contributions to learning by differentiating computer use for the simply motivational purposes she observed initially:

> I think the things we just talked about, they have to use it as a tool for teaching instead of just a reward. I mean, it can be used as a reward, too, because the kids aren't really going to learn anything from it; they will be excited about the computer for no reason. I think an exemplary teacher would have to have more than just a basic knowledge of technology for teaching. (Alex's third interview)

In contrast, Carrie and Stephanie reported mixed perceptions of the importance of technology. Carrie characterized the computer as "a helper" for motivating and teaching in a different way, but not necessarily as a contributor to learning: "Technology is not going to teach the kids, but it can help make things a little different." She emphasized the teacher's role in using computers appropriately: "I don't think using technology makes you a good or bad teacher. I think a good teacher would just use it as an aid and as a source of information." Likewise, Stephanie indicated that computers were not a "dominating factor" in the classroom, noting that computers could be used "on occasion when they want big stuff… that takes more than an hour of their time." In her characterizations of WebQuests, she considered computers to be an alternative to, rather than an integrated part of, everyday teaching: "It's a good thing to incorporate some lessons into instead of lecturing all the time…. If there is a like a boring subject that I have to teach, then I can be like, 'Okay, let's make it a WebQuest or a PowerPoint game.'"

Collectively, participants' perceptions and understanding about the educational roles of computers initially focused on potential rather than limitations. All identified new roles for technology, such as learning concepts and thinking skills, as well as motivation, interaction, and productivity. Recognition of technology's potential was the salient indicator. For example, Carrie considered PowerPoint games as useful in "a million and one ways," stating that they could provide interesting ways of learning content and thinking. Most participants' perceptions of computers evolved from seeing them as "extras" to seeing them as helpful learning tools. Participants began to acknowledge that computers could be helpful in terms of motivation, productivity, and learning. However, they emphasized balancing computer use with regular classroom teaching; the teacher remained the most important factor for the effective use of computers.

Discussion. Participant understanding about technology's roles evolved during the semester. Preconceived and initial understandings focused primarily on computer use for improving productivity and motivation. When preservice teachers initially considered and used computers according to these roles, they indicated that it would not contribute significantly to student learning. For example, they described motivation as useful for maintaining student interest and attention, but not for student learning. These findings are consistent with Russell et al.'s (2003) research, which indicated that experienced teachers used computers more often to teach content and to involve their students, while beginning teachers used computers mainly for lesson preparation, that is, their productivity.

The present study suggests that preservice teachers might be better served by focusing on specific computer uses rather than general uses. Consistent with Russell et al.'s (2003) findings, new teachers initially failed to recognize potential values and uses, but readily did so once provided with vicarious and first-hand experiences using computers in teaching and learning. As preservice teachers engaged specific computer programs and instructional methods via CBR, they began to identify student-centered computer roles and to use computers with learning content and thinking skills. Expert teachers' cases in the CBDT provided preservice teachers with vicarious experiences of using computers for student-centered learning and for learning content knowledge and thinking skills. In the case analyses, all participants identified such educational roles as pre-writing skills, organization of thinking, longer remembrance of content, or reasoning skills. They also addressed the teachers' facilitation roles and student-centered pedagogies, such as group work and research. Interpretation of experts' cases helps to clarify the expert's experiences and relate them to the novice's own cases (Riesbeck, 1996).

Therefore, the Web-enhanced CBR activity enabled participants to engage and address authentic teaching problems in ways that extended their initial and emerging beliefs and knowledge about computer use. All participants expressed an initial technology-oriented understanding of teaching with technology—that the main point was to learn a variety of computer programs. Computers were not integral to their conceptions of everyday classroom teaching. As participants engaged technology-based lessons during the course, Web-enhanced CBR activities (e.g., teachers' cases, writing in CBDT, and peer review) helped to scaffold the emergence of new orientations and ideas for teaching with technology. Understanding also evolved from positive but vague perceptions to concrete and clear roles situated in the contexts of authentic projects.

How does understanding about teaching with technology develop during Web-enhanced CBR?

Appendix O illustrates how concepts related to teaching with technology developed during the semester. These were manifest in various situations, such as in their individual case analyses, as criteria to make decisions for lesson and material development, and while discussing their perspectives on teaching with technology, and they addressed concepts such as teachers' roles, students' characteristics, pedagogy, technical and access issues, curriculum standards, and content. At the beginning of the course, preservice teachers expressed their initial conceptions about teaching with technology, most of which focused on one or two concepts. New concepts also emerged during CBR learning projects as participants developed new approaches via situated activities. Some concepts varied in accordance with new situations, while other concepts were applied in the same ways or were no longer used over time.

Perceived basic concepts. The preservice teachers started with basic concepts about teaching with technology at the beginning of the semester. Basic concepts were evident when identifying teaching philosophies, describing K-12 experiences about learning or teaching with technology, and communicating initial understanding about teaching with technology. Because all participants lacked experience teaching with technology, their initial understanding was shaped heavily by perceptions of their K-12 experiences as students and observations of other teachers' classrooms.

The concepts observed most frequently included teachers' roles, pedagogy, and technical and access issues. Teachers' roles for teaching with technology generally included individual technical skill and facilitation during implementation, such as direction and technical help. Cindy assessed her K-12 experience positively in terms of her teachers' clear direction and facilitation during online research in a computer lab. She focused on teachers' computer skills and technical problems related to teaching with technology:

> I enjoyed it when it worked. A lot of times these teachers had these glorious ideas of how they were going to do it, but there would be some complication and it wouldn't work, and then they'd get frustrated and they have to go plan B, which is not as exciting, and they didn't present it as exciting. When they did use it, it was neat to see, like for review games, just different programs. (Cindy's first interview)

Liz emphasized the teacher's facilitation role in computer-based lessons during a computer lab at the beginning of the semester. Her ideal images of teaching were to interact with students and to provide clear direction, "not just slapping it up on an overhead." She described her teacher's facilitation during Web searches: "In the time that we were researching during school, the teacher could help us find it or know if it was quality information or not." Liz also cited the importance of computer skill mastery in helping students learn to use programs at the beginning of the semester.

Describing her K-12 student experiences and sharing her initial understanding of teaching with technology, Carrie also cited the importance of teacher facilitation. She described negative experiences with computers when teachers "didn't really tell us which search engines were the best" as part of researching in a computer laboratory. In contrast, when initially characterizing the teacher's role based on her K-12 experiences and perspectives, Alex mentioned only that she considered teacher familiarity with programs as important to successful computer use. Stephanie recalled her teachers' helping to find Websites and to fix problems, but perceived learning with technology as "boring" when students put forth effort without facilitation.

Pedagogical issues for teaching with technology were also initially identified by all participants, based on their experiences of learning with technology. In classrooms, teachers commonly used PowerPoint to present topics, while in computer labs they typically asked students to conduct online searches for research resources:

> My history teacher did a lot of her presentations on PowerPoint and my economics teacher did PowerPoint stuff, but other than … mostly presenting their lecture. Or they'd give us a project and we'd have to do a PowerPoint presentation, but mostly presentations. (Carrie's first interview)

Cindy, Alex, and Stephanie cited technical and access issues as obstacles to teaching with technology. Liz also described budget issues: "There might not be enough money for computers or for software." All initially indicated significant access issues and increased potential for problems when computers were used: "Not knowing how to set it up and then with technology, it is not one hundred percent reliable. Like because the power can go out or the server could crash or your computer could get a virus" (Cindy's first interview).

Emerging concepts. As preservice teachers became increasingly involved in CBR activities, all participants identified new opportunities for teaching with technology. Cindy, Carrie, Stephanie, and Alex identified student characteristics as important to assessing teachers' cases and making project decisions. Their detailing of lesson activities was based heavily on student interests and attention; students' content understanding was also used to identify appropriate Websites as online resources. Alex and Carrie considered the characteristics of special education students in developing assessment and pedagogy for technology-enhanced lessons:

> I also thought the assessment would be different. The assessment I have for them [special education students] is more focused on their social skills working together in a group and actually following directions, whereas in general ed, I'd be looking for something a little deeper, like a little more content-based and not so much how they are interacting with each other and if they could follow rules, because they should be able to follow them. (Carrie's second interview)

Curriculum standards and content (i.e., subject matter) also emerged during projects because it was included in the CBDT template and was required for the lesson plan. The participants initially determined the content and grade for their projects and located relevant and appropriate curriculum standards. Although they did not demonstrate in-depth understanding of the curriculum standards, they considered them to be a priority for assessing their topic's validity and feasibility for real teaching situations. Carrie, lacking previous knowledge about curriculum standards in lesson plans, initially engaged in trial-and-error learning. As she attempted to naively apply the same content to a different grade level, she was unable to find a grade-appropriate curriculum standard. By the start of her third project, however, she identified the curriculum standard as a priority for deciding the project scenario.

Varied concepts. As the participants engaged CBR activities with different computer programs, they also developed and used several critical concepts for teaching with technology. Teachers' roles, students' characteristics, and pedagogy varied in the contexts of different projects as evident while analyzing teachers' video cases, deciding the scope of projects, developing the details of lesson plans and materials, and exchanging peer feedback.

During the semester, the participants varied the teachers' roles as facilitator, lesson planner, and computer user according to situation requirements. Facilitation ranged from motivating students to engage activities and learning to monitor and guide students' Internet searches during their WebQuests. Over the course of the semester, Cindy, for example, shifted her emphasis to providing clear instruction to and interacting with students, rather than preparing lesson plans and developing technology lesson materials.

Liz also increased her focus on teachers' facilitation during the semester. She recognized that a teacher in her video case addressed different student styles by providing visual information in Inspiration and a word processor, audio tape recordings, and hands-on activities; during her technology lesson planning, Liz focused on facilitating group work, providing technological help and supplying a Web search guide: "The teacher's role was to aid and assess." During her final interview, she concluded that teachers need opportunities to teach with technology rather than with lecturing, as well as to concurrently present and interact with students to increase awareness of their students' actions in the classrooms or computer labs.

In the case analysis, Alex noted that the teacher should enthusiastically facilitate student learning and promote students' ownership. During the PowerPoint game project, for example, she wrote the advice letter to her virtual novice teacher to clarify the reading levels of her students. Finally, Alex emphasized the importance of recognizing teachers' ideas on *how* to use computers rather than *whether* to use them: "I think instead of before, like knowing it was there and knowing that I should use it, and now I know how to and so that's going to make me more confident in using it."

Carrie focused on facilitation in special education, such as by involving, specializing, and motivating students. She suggested that teachers guide students' Internet searches, provide equal interaction, and provide energetic lessons. Stephanie stressed teacher facilitation during her case analysis: "She didn't really show them how to use the program too much….the children figured it out on their own." In an advice letter to her virtual novice teacher, she proposed that the teacher facilitate peer-to-peer interactions: "Instead of playing the game as a small group with only four children to a computer, you can make it an entire class game. You can read the questions to the children and the options for answers" (Stephanie's CBD report).

Microteaching projects enabled the preservice teachers to implement technology-enhanced lessons. Alex, for example, suggested her team's microteaching should be "more enthusiastic." She also evaluated other teams' efforts in terms of their facilitation: "I think they just forced you to get involved in it more." Participants reflected as teachers, rather than as college students, on their facilitation roles during implementation, focusing on taking initiative, interacting more, managing their time, and providing clear direction:
"I think our project went over well, but I felt like I was talking sort of plain. I saw that I needed to add some enthusiasm to my tone when playing the game in order to keep the kids more involved" (Stephanie's microteaching reflection).

The importance of the teachers' roles during lesson planning, not noted by participants at the beginning of the semester, became increasingly evident in the situated contexts of their CBR projects. The teacher's role as a lesson planner included the design of a reasonable timeline, clear representation of the content, and an articulation of students' activities. Stephanie recognized the importance of a timeline for learning when she initially planned to spend an entire week simply to find each community in the Inspiration project: "If it takes you 10 years to get the kids to the computer lab and get them situated, then you'll figure out if that is worth it or if you need to rethink your lesson plans." During the PowerPoint game project, Alex noted the need for time to plan computer use in lessons: "I think that project required more planning than I did originally." As a lesson planner, she identified the importance of "simple but crucial steps" when she developed the details of technology-enhanced lesson plans.

Since she developed lesson plans for the first time during the semester, Carrie focused on how to develop them. For example, she learned that teachers shared their lesson plans on Websites, some of which she adapted for her own project. Based on these positive experiences, she indicated that lesson plans should be clear and usable by other teachers. On the other hand, Cindy and Liz emphasized the teachers' facilitation roles over lesson planning. Cindy, for example, characterized facilitation as circulating in the classroom and guiding students on their projects, stating that she valued classroom implementation over lesson development experience.

The teachers' computer user role was evident when participants detailed their technology-based materials. For example, when they developed the game board for the

PowerPoint unit, participants emphasized technical aspects such as color, clip art, sound, and technical functions such as linking and menus. Liz noted:

> I will be using a power point [*sic*] template to create a power point [*sic*] game. I will use the components of PowerPoint to create different features of the game. I will be able to use clip art and import possible other features to make my game more creative. (Liz's PowerPoint game CBD report)

Liz also focused on technical and aesthetic aspects during peer feedback: "I told her to use more graphics and pictures to create a more aesthetically pleasing presentation."

Cindy, Alex, Carrie, and Stephanie actively considered student characteristics while engaged in Web-enhanced CBR activities. They noted several student characteristics: abilities in using computer programs, understanding content, and completing activities; preferences and interests; and individual differences. For abilities, they compared students in different grades and between general students and special education students; considerations were evident in judging project scope and appropriateness of Websites and resources. Student motivation, such as their preferences, attention, and interests, were evident in the details of their materials, such as the color, picture, and fonts of their Inspiration worksheets.

Cindy anticipated students' preferences and abilities as criteria for selecting other teachers' examples. During microteaching, she also provided feedback, noting directions that failed to provide sufficient attention to individual student differences. Alex also used students' abilities as criteria for Website selection and evaluation of her projects. Alex spent considerable time locating appropriate Websites for her 2nd-grade students. She characterized appropriate Websites as containing resources with "a lot of pictures," where “the font is bigger,” and where use was “simple.” Stephanie considered students’ abilities and interests in her decision to use Kidspiration instead of Inspiration: “They’d be excited and they would like to use that and use Kidspiration. I know that they like to be read to, like the younger children, as long as it is short because of their attention span.” Carrie adapted her assessment focus for special students on social skills: “Since it is a special education class, I will also be looking at the way the students interact together and how well they are working in a social situation.” Carrie also wrote about the level of students’ computer skills when she developed scenarios:

> My target students will be middle school-aged special education students. They are not very familiar at all with technology and only a few have used Microsoft word [*sic*]. Their disabilities range from autism to Down’s [*sic*] syndrome; most of the students have some type of severe mental disability. (Carrie’s Inspiration CBD report)

Various pedagogical methods for computer use were developed during CBR activities and were evident when the preservice teachers wrote their scenarios and analyzed teacher’s video cases. To develop scenarios, the preservice teachers also drafted the rough outlines of pedagogical methods, such as group work, searching online for research, debate, combination of lecturing concepts, and the combination of other software programs (e.g., PowerPoint) and media (e.g., video, microscope). Cindy, for example, varied her methods for computer use during the semester and included group work, research, video, experiments (microscopes), and news reports. Assuming limited ability among 3rd graders to conduct Web searches, she employed “guided” research during her Inspiration project.

Liz's pedagogical methods included Internet searches, group work, and lectures. She emphasized the importance of group work in the analysis of teachers' cases and the planning of her lesson. For example, Liz recognized that the teacher in one case did not use group work and suggested that sharing might enhance student understanding; she suggested that teachers step back and support student collaboration. She also used Inspiration and a PowerPoint game prior to or after teacher lecture to amplify important subject matter concepts.

Alex emphasized the importance of group work in improving student ownership and peer collaboration. In her advice for using her game with non-readers, she proposed collaborations with "more skilled readers," along with the teacher's clear direction:

> Since they were able to work together and explore the technology with a little more guidance from their teacher and classmates, they seemed to really enjoy it and learn a lot about tornado safety from it. However, since the class was working as a group, the only possible weakness would be in the assessment. (Alex's Inspiration CBD report)

Carrie used group work in all three projects. During the Inspiration lesson, she employed group research and debating and applied the software to generate a concept map for each group; in her WebQuest project, she recommended that students create their own roles. In her letter to the virtual beginning teacher, she advised peer help between "stronger" and nonreader students.

Vestigial/extinct concepts. Some issues, including those initially identified by participants and those that emerged during projects, such as curriculum standards, content (i.e., subject matter), and technical and access issues for teaching with technology, were either not used or were used without being further refined. Curriculum standards were integral to project scenarios and CBR activities. Since participants individually identified their scenarios based on personal experiences, curriculum standards were used to confirm decisions, and thus were used only during scenario work and initial planning. Alex decided the topic for her Inspiration project based on her experience and subsequently identified an appropriate standard: “Of course I used the QCC [Georgia’s Quality Core Curriculum] Website to pick a standard that I wanted to meet with this project and start generating ideas from that.” Participants sometimes failed to mention curriculum standards during scenario work and planning phases. Stephanie, for example, did not use clear curriculum standards for her WebQuest: “I don’t think I did, but I remember I saw that where it had to with geography, all the states, and then it had to do with the history of Georgia.”

Participants also appeared unconcerned with characteristics of the content or subject matter selected for their CBR activities, again focusing on them mainly during scenario work and development phases. Since participants selected subject matter content and levels for their projects based on personal experiences, preferences, or planned teaching specialties, most did not focus on these during their scenario work.

Participants noted that technical and access issues were obstacles for teaching with technology, but these issues rarely affected their decisions during CBR project work. Only Liz and Michelle expressed concern with computer access during their projects. Liz characterized access in terms of program availability and student numbers, attributing her rationale for using Inspiration to the need for handout materials for large classes in school settings. She stated in her final interview, “I’ll integrate a lot of the stuff, maybe even the Inspiration that I don’t have access to on a regular basis, but hopefully in the school setting

I would." Michelle accounted for the number of computers needed in her scenario work, noting that "the class is held in a normal classroom with about two computers" and that "each student will have their [*sic*] own computer."

Discussion. This study indicates that preservice teachers develop concepts during CBR activities that are important for teaching with technology. The concepts begin as simple and vague, but become more numerous and concrete, as well as increasingly refined, through their course projects. Consistent with previous research (Marx et al., 1994), individuals interpret and learn new concepts and practices based on their prior knowledge and beliefs. Teacher's roles and pedagogies, emphasized through the CBR activities, developed over the course of the semester; in contrast, technical and access issues were not emphasized during CBR activities and showed little growth. Since lesson planning was developed in simulated situations in this study and the enactments of development and microteaching occurred in a university computer lab, it is possible that participants assumed technical and access issues were addressed satisfactorily.

Beliefs and practices associated with facilitating, lesson planning, and computer use evolved dramatically in several instances. While perceptions about teachers' roles initially focused on implementation, participants became increasingly aware of the teacher's role as lesson planner as the course progressed. By analyzing teachers' cases and writing their plans in the CBDT, sharing lessons learned among teachers, and developing concrete lesson activities, participants refined and deepened their understanding about how to teach with technology. The role of planning in experts' teaching with technology practice underscores the importance of both lesson planning and implementation (Chisholm & Wetzel, 1997; Pierson, 2001; Russell et al., 2003).

Students' characteristics were identified and developed in various ways, primarily in accounting for abilities and motivations in instructional decision making. For example, when the preservice teachers were finding appropriate Web resources, the resources were evaluated and selected based on students' motivation and ability to understand the content rather than the content or appearance of the Website itself.

Many teacher development frameworks focus on students, curriculum, content, and pedagogy (e.g., Leinhardt & Greeno, 1986; Shulman, 1986). Developing and refining teacher knowledge about and skill in teaching with technology is fundamental to virtually all professional development frameworks (e.g., Fisher, 1997). By engaging the knowledge and wisdom of experienced teachers via case-based reasoning, preservice teachers used and developed their own teaching with technology knowledge and skill, demonstrating sophisticated understanding of the importance of understanding different roles, pedagogies, and student characteristics.

Implications for the Development of Situated Knowledge

This section presents implications and rationales for situating preservice teachers' experiences in the value and culture of practicing teachers, specifically focusing on conceptual case knowledge and socially shared identities and beliefs for teaching with technology.

Conceptual Case Knowledge

As discussed previously, conceptual case knowledge emphasizes what you know, or domain knowledge. Preservice teachers' conceptual case knowledge—in this study the understanding of educational roles and various factors for teaching with technology—is initially impoverished. The nature of conceptual case knowledge, “indexicalized representations” (Brown et al., 1989, p. 37) consisting of knowledge structures interwoven into various situations, is inherently constrained among preservice teachers due to their limited prior teaching experience. Lacking opportunities to bridge this experience gap, preservice teachers have been left to “find their own way” once they assume the roles and responsibilities of practicing teachers.

Findings of this study indicate that preservice teachers improved their knowledge of teaching with technology, as well as their practices, across a range of teacher roles, including facilitator, lesson planer, and computer user. They accounted for student motivation and characteristics, such as ability to learn domain content, use technology, and engage instructional activities. Further, they learned and applied diverse pedagogical methods such as group work, research, searching for resources, and lecture (presentation), and accounted for content, curriculum standards, access issues, and technical problems. Teacher pedagogical content knowledge generally includes knowledge of students, curriculum, content, and pedagogy (Leinhardt & Greeno, 1986; Shulman, 1986). Knowledge for teaching with technology requires linking computer skills with associated curriculum and pedagogical strategies (Fisher, 1997). In this study, preservice teachers’ understanding was shaped by and responsive to the cultural values and practices of the teaching with technology community (Collins et al., 1989).

While knowledge reflected various concepts of various depth and complexity, preservice teachers’ understanding of teachers’ roles, students’ characteristics, and pedagogical methods were mostly developed and applied during Web-enhanced CBR activities, where those values and practices were emphasized. On the other hand, little further knowledge developed related to content, curriculum, technical, and access issues. Although the course in this study focused more on pedagogy for computer use than on content, practicing computer use for specific content and curriculum is also needed in preservice education. Researchers (e.g., Ertmer, 1999; Pierson, 2001; Windschitl & Sahl, 2002) have noted that exemplary teachers' depth of content and curriculum knowledge influences their use of technology.

The development of teacher knowledge was embedded within the course project context. That is, the context for using a particular program (e.g., Inspiration, PowerPoint) for teaching included both the knowledge structure and concepts. For example, preservice teachers learned how educators use Inspiration in a classroom, considering several concepts: using Inspiration for research (pedagogical roles), having group discussion regarding making a web (pedagogy), teachers' guidelines for research and demonstrating how to use Inspiration (teachers' roles), limiting the online resources for third-grade students (students' ability), assuring the appropriate curriculum standards (curriculum standards), and assessment (content). As a result, preservice teachers develop varied conceptual case knowledge about how to teach by integrating concepts within context, enabling preservice teachers to build collections of their own case libraries (Kolodner, 1993).

Socially Shared Beliefs and Identities

From the situated cognition perspective, learning as enculturation includes identity development and meaning negotiation that is shared by a community (Brown et al., 1989; Lave & Wenger, 1991). In the context of teaching with technology, many researchers report that exemplary teachers espouse a constructivist epistemology and a student-centered pedagogy (e.g., collaboration and research) when they use computers for teaching and learning (Becker, 1994; Becker & Ravitz, 1999; Ertmer et al., 2000; OTA, 1995; Windschitl & Sahl, 2002).

In this study, all preservice teachers initially described ideal teaching as using constructivist approaches such as interactive and interesting learning and collaboration; their technology-enhanced pedagogy (e.g., online research, group work, combination of hands-on activities, and debates) reflected these approaches. Preservice teachers shared the pedagogical beliefs and approaches of the practicing teaching with technology community. Literature, however, differentiates between espoused beliefs (i.e., what is said, or expressed beliefs) and beliefs-in-action (i.e., what is done, or acted beliefs) (Pajares, 1992). In this respect, we cannot be certain that preservice teachers have constructivist pedagogical beliefs and approaches until they teach in actual classrooms.

The findings also suggest that constructivist pedagogical approaches, per se, do not guarantee a meaningful use of technology. In this study, computers were largely used by preservice teachers to supplement constructivist pedagogical methods. For example, Cindy developed a lesson plan to support students' research using group work, online searching, and simulated broadcasting. Technology, however, was used to introduce the project (i.e., as a presentation tool) rather than to support research. Likewise, Carrie considered the WebQuest as a "resource tool" to find information rather than a learning tool to support constructivist inquiry.

Exemplary constructivist teachers consider themselves to be facilitators, collaborators, and co-learners with students (Becker, 1994; Becker & Ravitz, 1999; OTA, 1995; Windschitl & Sahl, 2002). In this study, preservice teachers' perceptions of facilitation often focused on monitoring and classroom management, such as providing directions about activities, demonstrating how to use programs, controlling Websites, and fixing technological problems. However, during microteaching, only one participant's demonstration significantly facilitated student work or promoted collaboration. PowerPoint games often assumed a question-and-answer lecture format rather than student generation of knowledge artifacts. To bridge this gap, practices for implementing authentic lesson plans should be emphasized during CBR activities. These practices might facilitate preservice teachers' identities as collaborators and co-learners, identities not observed during this current study.

Limitations and Conclusion

Two limitations of this study are noteworthy. First, the situated learning conceptual framework may be too comprehensive to apply to preservice teachers' learning in a single semester, as it emphasizes a comprehensive understanding of people's activities in the world rather than learning in a particular space and time (Lave & Wenger, 1991). Although the perspective is critical in explaining preservice teachers' learning in teacher education as part of life-long professional development, a semester-long study may not be sufficient for adequately exploring the emergence of situated knowledge. The processes of gaining situated knowledge may be more readily discernible in a longitudinal study.

Next, the five female participants are not representative cases for preservice teachers' learning for teaching with technology; rather, they are individual examples. In addition, during data collection, the course included seven other students majoring in education and eleven students not majoring in education. For peer reviews and collaborations, the instructor placed education majors together. However, it is possible that non-majors may have influenced the learning and perspective development of education majors who participated in the study.

Nevertheless, the findings demonstrate that preservice teachers who were provided the opportunity to gain the situated knowledge of exemplary teachers in a university classroom developed their perspectives and understanding for teaching with technology. Two implications for future research studies are apparent. First, from the situated cognition perspective, socially shared meaning and perspective development, essential in learning, are constructed via participation in community-based social practices. While preservice teachers constructed socially shared meaning and engaged experienced teachers' cases, their instructor, and their peers, the study focused on individual perceptions and learning. Observations of social practices such as case discussion and conversations are needed to inform how preservice teachers develop socially shared meaning and perspectives.

Next, the situated learning perspective focuses on whole person development through activity in the world. In this respect, teacher learning may be better explained by a sustained longitudinal study rather than a discrete snapshot of preservice teachers in a Web-enhanced CBR course. Web-enhanced CBR learning has potential to both support preservice teachers' situated learning in university classrooms and to explain the development of situated knowledge over time. Research is needed to refine our understanding of CBR's potential and pitfalls for both discrete and sustained learning.

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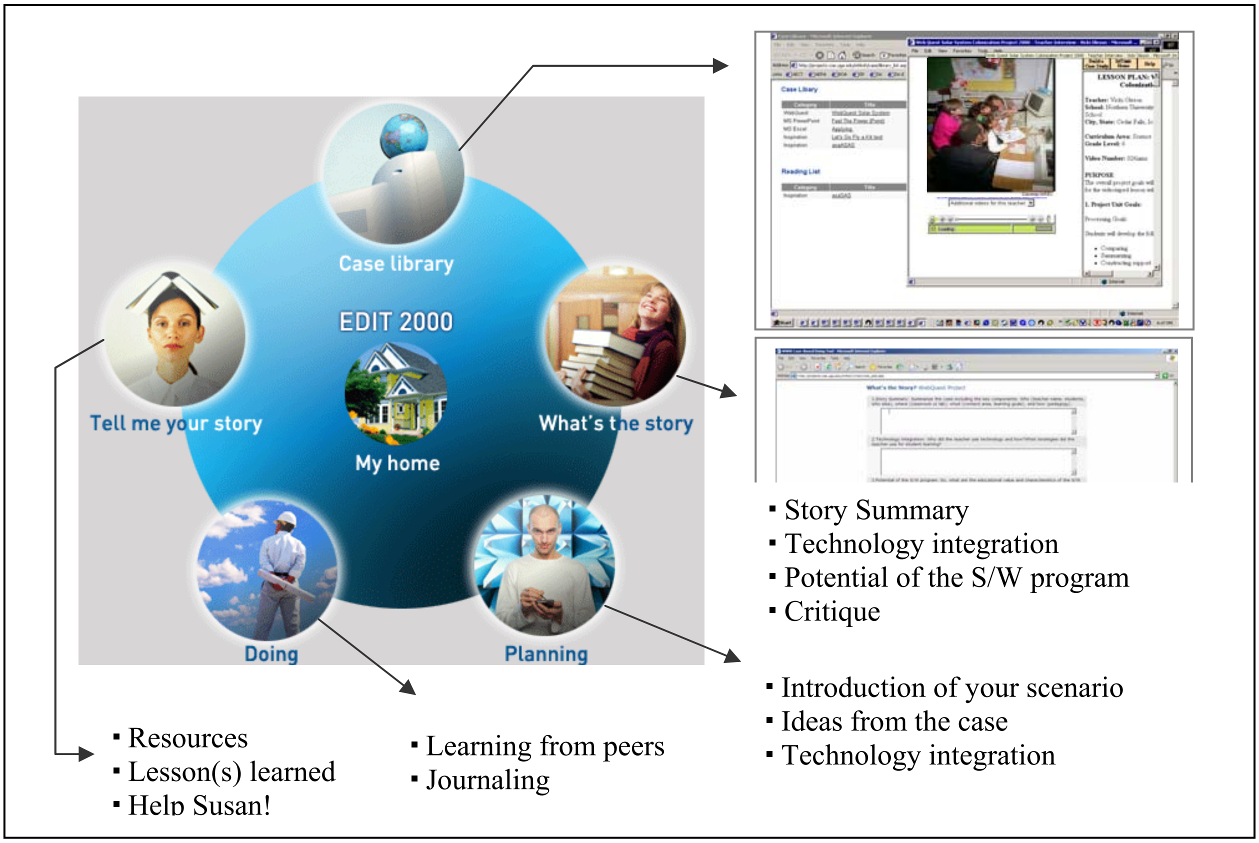

Figure 3.1. The screen shot and template structure of the Web-based case-based doing tool (CBDT).

CHAPTER 4

WEB-ENHANCED CASE-BASED REASONING IN PRESERVICE TEACHER EDUCATION: A CASE STUDY[4]

[4] Kim, H., & Hannafin, M. J. To be submitted to *Educational Technology Research and Development*.

Abstract

Case methods, used to support situated learning in higher education, contextualize case narratives and facilitate case discussions between instructors and students. Recent work in case-based reasoning (CBR) reinforces the importance of situated learning, expert cases, and authentic tasks and activities. As novices are engaged in CBR learning environments, they participate in social practices as apprentices to develop expert-like strategies such as routinization, reflection, heuristics, and collaboration. This study examines how preservice teachers, as novices in a semester-long Web-enhanced CBR learning environment, engage CBR activities to understand the culture and concepts of teaching with technology, using experts' cases. Five preservice teachers used automatizing, analyzing, articulating, and interweaving strategies during Web-enhanced CBR activities, which catalyzed and framed their understanding of the culture of and approaches to teaching with technology.

Cases have been used for educational purposes for many years. Case methods have become a hallmark of professional education in the form of case studies and case-based curricula (Masoner, 1988; Merseth, 1996; Shulman, 1992; Williams, 1992). As constructivist-inspired learning environments (The Cognition and Technology Group at Vanderbilt, 1990; Hmelo-Silver, 2004; Spiro, Feltovich, Jacobson, & Coulson, 1992) and situated learning perspectives (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991) have emerged, case methods have been considered crucial for situated learning in terms of the nature of cases and the methods of using cases. Shulman (1992), for example, notes that "the character of the narrative form may be particularly well suited to the situatedness of the learning process" (p. 24). He further argues that the contextualization that cases afford as instruction supports both initial learning and transfer. Other applications of case-based approaches have been cited as well. Some authorities consider case discussions as tools for improving social discourse and strengthening learning communities (Harrington & Garrison, 1992; Levin, 1995; Merseth, 1996). Carter (1989), for instance, suggests that teacher-led case analysis approximates an apprenticeship environment, simulating dialog in the form of stories between mentors and novices. Case methods, however, need new approaches in order to satisfy the critical assumptions of situated learning perspectives; learning and acting are inseparable, and experience is provided through authentic activity (Brown et al., 1989). Knowledge both evolves continuously in new situations and results from interactions during activity.

Recent work in case-based reasoning (CBR) reinforces the importance of authentic activity in, and provides important theoretical grounding for, situated learning (Kolodner & Guzdial, 2000; Kolodner, Owensby, & Guzdial, 2004; Schank, Berman, & Macpherson, 1999). Case-based reasoning theory has been used to explain human reasoning and cognition processes, equating individual knowledge with cases as represented and retrieved in the form of stories (Kolodner, 1993; Schank, 1999). Case-based reasoning assumes that humans think in terms of cases and interpretations of experiences, reflecting a natural model of human learning, particularly experts' thinking (Schank, 1999). For educational applications, CBR emphasizes the role of experts' exemplar cases as the external repository of experiences for novices' projects (Kolodner et al., 2004; Schank et al., 1999). When novice learners use experts' cases for their projects, they can interact with and learn from experts' insights and tacit knowledge, such as an apprenticeship in real-world practices. Accordingly, CBR learning includes ill-structured, authentic tasks, activities, and decision points, as well as experts' reasoning as embodied in exemplary cases. Case-based reasoning approaches situate novices' learning by providing rich context and culture, along with apprenticeship experiences and opportunities to "learn by doing" (Schank, 1994/1994; Stevens, Collins, & Goldin, 1982). Over the past decade, varied ways of using cases, different frameworks for explaining the effects of case-based learning, and alternative approaches to the design of CBR have emerged.

While research studies have reported that case methods, mostly case discussion and written analysis in dilemma-based cases, help to contextualize understanding of theories, multiple perspectives, problem solving skills, and reflection (Harrington, 1995; Harrington & Garrison, 1992; Lundeberg, 1999; Merseth, 1996; Tippins, Koballa, & Payne, 2002), teacher learning during CBR, as situated learning pedagogy, is relatively new. Preservice teachers typically lack the first-hand teaching insights of experienced teachers; case-based learning and activity may enable novice teachers to access and participate in authentically situated experiences of practicing teachers. Thus, case-based approaches may enable novice teachers to engage and participate in the ordinary practices of a teaching community.

Kim and Hannafin's (2005) framework characterizes how expert teachers' experiences and practices can be represented and shared via Web-enhanced CBR. From situated cognition and learning perspectives, experts often draw upon strategic knowledge, "the usually tacit knowledge that underlies an expert's ability to make use of concepts, facts, and procedures as necessary to solve problems and carry out tasks" (Collins, Brown, & Newman, 1989, p. 477). Experts use routinized, reflective, collaborative, and heuristic strategic knowledge flexibly to identify the complexity and diversity of problem situations and to reference associated conceptual knowledge. Expert teachers routinize activities where they have established experience upon which to draw, enabling them to respond efficiently as they modify how and when to enact given practices (Leinhardt & Greeno, 1986). During reflective practice, experts think and act by assembling sets of principles to explain and predict events; activity and thinking arise simultaneously in order to identify the purpose of activity and to assess a situation (Brown et al., 1989; Schank, 1999; Schön, 1983). Collaboration also enables novices to participate in the culture and practice of a community (Greeno et al., 1998; Lave & Wenger, 1991). For example, successful teachers envision and implement technology use through ongoing conversation, engagement in mutual technology initiatives, and shared time to plan with colleagues and experts (Ertmer, 1999; Glazer, Hannafin, & Song, in press). Finally, heuristics focus on tacit knowledge and the wisdom underlying practices: "Heuristic strategies are generally effective techniques and approaches for accomplishing tasks that might be regarded as 'tricks of the trade'; they don't always work, but when they do, they are quite helpful" (Collins et al., 1989, p. 478).

Through Web-enhanced CBR, preservice teachers may engage authentic problems and participate in authentic activities with the support and guidance of experts while engaging the otherwise tacit expert knowledge of a teaching community. The purpose of this study was to examine preservice teachers' learning processes in and interaction with Web-enhanced CBR activities. Two research questions guided this study:

1. What strategies do preservice teachers use and develop for Web-enhanced CBR activities?
2. How do preservice teachers use the structure and components of the Web-enhanced CBR activity?

Method

Research Design, Setting, and Participants

A case study was employed in order to deeply understand the phenomenon, the process, the perspectives of the people involved, and the combinations of each (Merriam, 2002). A case was defined as each preservice teacher's perspective and learning in the Web-enhanced CBR course; each case was considered to be a phenomenon in a bounded context (Miles & Huberman, 1994).

The course was an introductory technology integration course for preservice teachers offered in the College of Education of a large Southeastern university during the fall semester of 2004. The course was organized in terms of software programs (e.g., Inspiration, Microsoft Office) and featured project requirements that involved software programs (Appendix B). The present research focused on the CBR unit, while both CBR and non-CBR units and requirements were included in the course. Web-enhanced CBR units covered 10 weeks of the 16-week course. All enrollees, whether educational majors or not, were involved in both CBR and non-CBR units and requirements as part of their coursework. Because this course was designed for preservice teachers, all students enrolled were asked to develop lesson plans and teaching materials for technology use in classroom contexts during CBR units.

Of the 18 undergraduate enrollees, the first author collected data on all 7 preservice teachers and conducted in-depth data analysis on 5 based on the amount and quality of information provided and the diversity of sampling with respect to their grades, prior experience, initial technical skills, and understanding of technology integration. Maximum variation sampling was used to find various cases in a reliable way (Glaser & Strauss, 1967). For example, there are various departments, such as early childhood education, special education, and middle education, as well as different grade levels, from junior to senior. Accordingly, we selected 5 of 7 preservice teachers by discarding 2 participants based on poor quality of information and information that overlapped with other participants. For example, we selected Stephanie and Carrie, rather than Erin, because they were a sophomore and a transferred junior with no prior teaching and lesson planning experiences. Stephanie and Erin both had initially self-reported a high level of technology skills and were majoring or planning to major in the same department.

Individual summaries of five participants are shown in Appendix A. Two participants reported both teaching and lesson planning experience, one reported only teaching experience, and two had neither teaching nor lesson planning experience. None reported experience teaching with technology.

Web-enhanced CBR Learning Environment

Based on cognitive assumptions and educational implications, we designed the Web-enhanced CBR learning environment for preservice teachers. Figure 4.1 illustrates the structure and components of the Web-enhanced CBR learning. In the current study, preservice teachers participated in three projects to develop lesson plans and instructional materials for teaching with technology: an Inspiration project, a PowerPoint game, and a WebQuest. Inspiration was selected for the first unit because it is simple to learn and use. The final products for the Inspiration unit included a lesson plan describing the computer application use in teaching or learning, as well as application-generated instructional materials (e.g., worksheets) (see Appendix D for sample Inspiration materials). During the second project, preservice teachers developed a PowerPoint game as an instructional material for a lesson context of their own choosing. The final products included PowerPoint games and game board in an electronic or printed format (see Appendix E for an example). The WebQuest project, which involved creating a Web-based lesson plan and related material in a structured format, including the introduction of the project and information regarding the learners, tasks, process, evaluation, and conclusion (see Appendix F). In both the PowerPoint game and the WebQuest project, additional lesson plans were not included because the projects focused more on activities than simple worksheets or instructional materials. However, the preservice teachers were asked to consider the lesson context holistically, including grade, subject matter, learning activity, and the role of the PowerPoint game or WebQuest, in their unit. Near the end of the semester, each participant conducted a 15-minute microteaching session featuring one of his or her CBR course projects in order to practice implementing the technology-enhanced lessons.

To complete their three project tasks, preservice teachers were instructed to follow the structure supplied in Web-enhanced CBR activities. As shown in Appendix C, the CBR cycle was used to scaffold CBR phases and activities for each individual project. Each phase consisted of a progression of structured CBR activities: introducing a novel case (scenario work), accessing analogous cases using learners' own case knowledge or that provided by an expert teacher (case analysis), attempting to interpret and analyze the new case and proposing preliminary solutions (planning), adapting and applying the solution (doing), reflecting on new case knowledge (reflecting). Throughout the process, the instructor provided ongoing coaching and feedback, peer feedback was available, and a wide array of Web resources was provided.

Web-enhanced case base doing tool (CBDT). The case-based doing tool was developed to facilitate reflective practices by presenting expert teachers' cases and CBR scaffolds in template form. Figure 4.2 illustrates the structure of the CBDT, consisting of a case library and CBR scaffolds (Appendix G contains a copy of the manual).

The *case library* provides "the presence of experts" (Riesbeck, 1996, p. 59) and includes expert teachers' stories (via interviews) in the form of narratives. These narratives enable learners to better understand the interpretations and actions of experts in context and to reference experts' case libraries during their problem solving. The CBDT case library contained links to exemplary cases or case sites and resources (e.g., articles about particular cases); both cases and resources could be added or deleted by an administrator. The Web-based cases and the resources presented multiple formats, such as experts' interviews, captured classroom situations, work samples, and related archival data. Web affordances also allowed rapid retrieval of personal case libraries so that learners could practice finding and using knowledge during their own problem solving.

The CBDT case library of expert teachers' teaching with computers contained two video cases featuring approaches to *Integrating New Technologies Into the Methods of Education* (*InTime:* Grabe & Grabe, 2001), during which experts provided exemplars (including sample lesson plans) of teachers using computers in K-12 contexts. In addition, the instructor in this study produced one additional video case for the PowerPoint games because an exemplary case was not available. Two video clips, such as an activity overview and a teacher interview, were presented for each case during class, providing classroom context and teacher narratives.

The first video case (http://www.intime.uni.edu/video/048vaue/8/), Night of the Twisters, focused on teacher use of Inspiration software to teach language arts to 5th- and 6th-grade special education students. Students in the case used Inspiration to make concept maps to predict the outcome of a story about tornados and to access their prior knowledge before listening to the actual story on tape. They also discussed the story by comparing their predictions and the actual story prior to conducting online research about tornados. The teacher used Inspiration along with other technologies, such as Microsoft Word and cassette tapes. The second video case, PowerPoint games, showed how students used the software as a learning tool by creating their own games to demonstrate conceptual understanding. During the case, the teacher described how she guided students' projects and gauged benefits and risks. The WebQuest Solar System Colonization Project 2000, the third video case, presented how the teacher used a WebQuest to teach 6th-grade science (http://www.intime.uni.edu/video/026iams/0/). Following the structure of a WebQuest, the teacher introduced the project and provided background information about student projects. The students were given the mission of searching the solar system for a new colony site due to Earth's overpopulation. In groups, each student assumed a role, such as astronomer, meteorologist, geologist, psychologist/sociologist, or biologist, and conducted online research to complete the mission.

Cases from the *Knowledge Innovation for Technology in Education Project* (*KITE:* Wang, Moore, Wedman, & Shyu, 2003) were also provided to assist preservice teachers. The Web-based cases presented exemplary teachers' stories about their computer use in the format of text. Because the *KITE* project contains over 1000 cases, preservice teachers used it to search for additional information or examples related to their projects.

CBR scaffolds were provided in the form of guiding CBDT questions, instantiating the major CBR components, such as the use of one's own and others' case libraries, goal setting, situation assessment, encountering and learning from expectation failure, and rebuilding one's own case library (Kolodner et al., 2004; Schank et al., 1999). Consistent with the sequence of the Web-enhanced CBR activities, CBR scaffolds were organized into four parts: *what's the story* (i.e., case analysis), *planning* (i.e., scenario work and planning), *doing*, and *tell me your story* (i.e., reflection). Each category included 2 to 4 sub-titles, along with guiding questions, to facilitate contextual and conceptual understanding and CBR. Contextual understanding was facilitated by providing additional contextual support such as *who* (target students' grades and characteristics, such as prior knowledge and technology skills), *where* (e.g., classroom, lab, field), *what* (content area, learning goals), and *how* (pedagogy), since stories or narratives with plots are natural means for storing experiences and sharing knowledge (Bruner, 1986; Lave & Wenger, 1991; Schank, 1999).

Conceptual understanding was supported by embedding the major concepts for teaching with and without technology, including technology integration, the potential of the software program, students' characteristics, content, curriculum standards, and pedagogy, in the CBDT templates (Fisher, 1997; Leinhardt & Greeno, 1986; Shulman, 1986). To refine CBDT questions and interface design, a pilot study (Kim & Hannafin, 2005a) was conducted during Spring of 2004. CBDT methods and tools were refined based on information collected from interviews with, and two short evaluation surveys completed by, nine enrolled preservice educators in the pilot study. As a result, the prompt questions of the CBDT were refined to better support critical thinking rather than to report on factual events. For example, a "critique" option was added to teachers' video cases for case analysis. The "help Susan" option in *tell me your story* (i.e., reflection), in which preservice teachers are asked to write to a beginner teacher regarding a relevant situation for technology use, was added to support transfer. Collaboration was strengthened by adding peer feedback to the CBR activity for each project, as well as to the templates of the CBDT (i.e., learning from peers). During CBR learning activities, scaffolds helped learners to identify and organize problems and ideas (Kolodner et al., 2004). Because they wrote in the CBDT during each phase, the scaffolds facilitated preservice teachers' simultaneous thinking and acting.

The *what's the story* scaffold, provided to help interpretation and analysis of exemplar cases relevant to given tasks and scenarios, consisted of four templates: (1) Story summary, (2) technology integration, (3) Potential of the software program, and (4) Critique. "Story summary" was designed to facilitate both contextual and conceptual understanding about the case by asking the learner to "summarize the case, including the key components: Who (teacher name, students, who else), where (classroom or lab), what (content area, learning goals), and how (pedagogy)." The "Technology integration" and "Potential of the software program" templates facilitated in-depth case interpretation of critical concepts evident in cases. Preservice teachers also interpreted the cases beyond the case summary to assess both their own and exemplary cases through the "Critique" template, prompting them to identify strong and weak points, possible obstacles, and applicability to individual projects.

Using the *planning* feature, preservice teachers wrote their plans and created or revised their scenarios as necessary. An "Introduction to your scenario" scaffold was used by participants to write their project scenarios in the CBDT per guiding questions: "Describe and refine your scenario including the key components: Who (target students' grade and characteristics, such as prior knowledge and technology skills), where (classroom, lab, field), what (content area, learning goal (QCC), etc.), and how (pedagogy)." Preservice teachers created their initial scenarios and revised them subsequently as needed. They were guided to focus on the expert teachers' ideas and important concepts through the "Ideas from the case" and "Technology integration" templates.

The *doing* CBR scaffold supported reflective activity. Generally, doing includes developing products, playing piano, and cooking food (Kolodner et al., 2004; Schank et al., 1999). In the doing phase, preservice teachers developed lesson plans and teaching materials using unit-specific software (e.g., concept maps using Inspiration or game materials using PowerPoint). Although doing focuses on performance, it requires that individuals reflect on their actions by comparing and revising their plans. The case-based doing tool provides learners with the opportunity to practice their reflective practices via journaling and reflection from peer feedback sessions (i.e., Learning from peers). The "Journaling" template asked preservice teachers to keep track of their doing. Another CBR scaffold, "Learning from peers," was provided to facilitate idea generation and sharing as preservice teachers practiced how to articulate ideas and learn the culture and conventions of their community of practice (Brown et al., 1989; Lave & Wenger, 1991).

The *tell me your story* template supported reflection and transfer as individuals reflected holistically on their experiences. The CBR scaffold included "Resources," "Lesson(s) learned," "Help Susan!," and "Other thoughts." The reflection functions guided learners to describe their experiences in the form of a story to recall specific concrete, contextual incidents along with their perceptions about the events. The "Resources" template, for example, helped participants to consider their project experiences as they completed the CBR activities. The "Lesson(s) learned" template asked learners to identify key ideas and insights gained from their experience and to describe their application to future projects. The "Help Susan!" feature was provided for facilitating potential transfer to new situations by writing a letter to a peer beginning teacher, Susan, who may encounter a similar challenge in a different situation. Ms. Susan Jones, a virtual beginner teacher, would tell the learners that it was difficult for her to implement technology lessons and note difficult situations in integrating certain familiar software in her class. Preservice teachers were given a printed letter from Susan as a handout in class (Appendix I) and wrote their reply letter via CBDT. At the end of the project, each preservice teacher generated a CBD report printed from the CBDT and submitted it to the instructor, along with a lesson plan and materials (Appendix H).

Procedures

As outlined in Appendix L, the current study was implemented over the course of a 16-week semester in the fall of 2004 and included a preliminary phase, Web-enhanced CBR activities, and a final phase. The preliminary phase covered weeks 1-5 of the semester. This period consisted of an introduction to the course, orientation to the research study, and non-CBR unit assignments. During the first class meeting, the instructor introduced the research study and identified the researcher as a technical assistant who had no influence over students' grades. In addition, information sheets of enrollees' demographic data, prior teaching and lesson planning experiences, educational courses taken, and perceived technology skills for particular programs (e.g., PowerPoint) were collected.

During the preliminary phase, the non-CBR units consisted of the instructor's introduction of a new project and demonstration of software programs, followed by preservice teachers' material development. The course assignments included sending an email with an attachment to the instructor; using Microsoft Office to develope newsletters, seating charts, and business cards searching for examples of lesson plans using Georgia Learning Connection (GLC) Websites; and developing the initial frame of their e-portfolio Websites with Dreamweaver software. Because 7 students were identified as preservice teachers, the researcher collected and analyzed potential participants' data, including their information sheets and course artifacts, along with observation notes for the preliminary interview.

After explaining the details of the study and recruiting participants during week 3, a preliminary interview was conducted with each participant prior to the CBR units during weeks 4 and 5 in order to chronicle the development of understanding resulting from the

CBR learning activities and non-CBR course projects. The result provided the summary story of each participant, along with initial codes and themes.

During weeks 6-16, Web-enhanced CBR units focusing on Inspiration, PowerPoint games, WebQuests, and microteaching projects were implemented. The Inspiration project was implemented during weeks 6-7. Because this project was the first Web-enhanced CBR unit, the instructor introduced the CBR activity and demonstrated how to use CBDT. The researcher provided technical help when needed. However, technical difficulties rarely occurred because most students found CBDT easy to use during the first project. Cindy, however, had difficulty writing in CBDT. She wrote her case analysis (i.e. *what's the story*) in the reflection section (i.e., *tell me your story*) because of the similarity between the two template titles. Participants wrote in CBDT mostly in class. They occasionally watched teacher video cases multiple times to write their case analyses in the *what's the story* section of CBDT. After case analysis, they used CBDT before or after their activity to both brainstorm and reflect. Because the preservice teachers' task was to develop instructional materials (e.g., teacher's handout or student's work sample) and the lesson plan, lesson plan templates were provided to support development and to standardize lesson plan formats. The preservice teachers followed the sequence of the CBR activity, which included writing their scenarios, watching and analyzing the teacher's case, planning and developing their lesson plan and material using Inspiration, and reflecting on their practice.

For peer feedback, the instructor paired off preservice teachers to approximate a practicing community (Lave & Wenger, 1991). Since an odd number of preservice students were enrolled, one participant was paired off with an exchange student who was also an education major. The instructor also engaged in personal, ongoing conversations with the participants when asked. The researcher observed participants' CBR activity and use of CBDT and collected artifacts from their Inspiration projects. She also discussed participants' reactions and activities with the instructor.

The second CBR activity, the PowerPoint game, occurred during weeks 8-10 and began with an introduction of instructional games by the instructor to motivate participants to develop their own games. The instructor also demonstrated advanced PowerPoint functions, such as the use of sound, animations, and clip art, before participants began developing the details of their game. The researcher conducted the second interviews between weeks 8 and 10 and collected CBD reports, artifacts, peer feedback sheets, field notes, and course materials as they became available.

During week 11, all students participated in a unit focusing on accessing and using Web resources in constructing lesson plans; this unit ensured that participants had sufficient Web familiarity and foundation skills needed for the WebQuest project. The Web unit involved creating Web-based lesson plans and guided participants in identifying and selecting material using structured prompts, including the introduction of the project and information regarding the learners, tasks, process, evaluation, and conclusion.

The WebQuest unit, conducted during weeks 12-14, began with an introduction, examples, and templates available on the WebQuest Website. Preservice teachers initially created a context for their WebQuests, then studied expert teachers' WebQuest cases in the CBDT. In the CBDT, they wrote their case analyses and elaborated their initial plans per the WebQuest template. They generally began by writing in the *Introduction* section and finding instructional Websites. During the WebQuest class activities, the researcher observed participants' activities and collected artifacts such as peer feedback sheets, printed WebQuests, and CBD reports.

During weeks 15-16, each pair of preservice teachers presented a 15-minute, technology-enhanced microteaching lesson to their classmates and instructor using one of their course projects (i.e., Inspiration, PowerPoint game, or WebQuest). Each microteaching session was videotaped so presenters could review them later to facilitate reflection. Following the presentations, the instructor and class members provided written feedback to the presenters. The instructor scaffolded participant performance by directing, demonstrating, modeling, monitoring, and coaching through the CBR process. Peer review supported the exchange of feedback for lesson plans and materials, while Web resources enabled preservice teachers to align their lessons with curriculum standards and to use diverse examples of technology-enhanced lessons.

Final interviews were conducted during the microteaching sessions and completed within 4 weeks of the end of the course. The researcher conducted all but one of the final interviews within 2 weeks of the course's completion; due to an unanticipated lack of availability, the remaining interview was conducted 4 weeks after the course ended. At the end of the semester, the researcher interviewed the instructor to determine perceptions of participants' learning and the effectiveness of the CBR activities. Preservice teachers' final CBD reports, course artifacts, field notes, and microteaching video tapes were also collected in the final phase.

Data Sources

In-depth qualitative interviews and CBD reports were used as primary data sources (Appendix J). Three semi-structured interviews with preservice teachers were conducted at the beginning, middle, and end of the semester; an interview with the instructor was also conducted at the end of the course to supplement student interviews (see Appendix K). The first interview was used to identify participants' backgrounds and experiences. The second and third interviews probed the process of completing course projects, focusing on participants' decisions, perceptions, and use of components (i.e., peer feedback, Web resources) and the CBDT. The third interview also probed participants' process of projects, final perceptions of Web-enhanced CBR activities and the CBDT, and overall reflection on the course itself. Interviews lasted between 30 and 60 minutes; all were tape-recorded and transcribed.

Case-based doing reports, printed from copies of preservice teachers' writings in the Web-based CBDT, were also collected. Each report consisted of (a) *what's the story* (i.e., case analysis), (b) *planning*, (c) *doing*, and (d) *tell me your story* (i.e., reflection). The CBD reports were used as evidence of participants' strategies and use of Web-enhanced CBR activities and CBDT. In addition, artifacts (e.g., Inspiration lesson plans and instructional materials), memos from ongoing conversations with the instructor, other course materials, video recordings of microteaching sessions, and field notes from class observations were collected to supplement the primary data.

Analysis

The constant comparative method (Strauss & Corbin, 1998) was used for data analysis and consisted of open coding, comparing emerging themes, and refining categories. For open coding, the researcher coded the majority of the data using the Atlas.ti 4.2 software program. Open coding resulted in several codes, which were grouped according to themes. For example, during case analysis, participants indicated patterns such as "identifying" students' reactions, "characterizing" software programs, and "criticizing" the teacher's facilitation"; during planning, they also analyzed their own lesson plan situations by "assessing" target students' abilities to use Websites and "identifying" the benefits of the pedagogy to be used. These codes were grouped under the theme "characterizing" situations for teaching with technology. Participants also interpreted teachers' cases by associating them with their own projects and referring to the characteristics of their project (e.g., students' characteristics and pedagogy). These codes were grouped under the theme "comparing" situations for teaching with technology. These groups were classified into the larger category, "analyzing" situations. As a result, a list of the tentative categories and subcategories was created for each case.

Data analysis for the second case was conducted after the list of the codes for the first case had been determined such that categories about individual learning as a unit of each case could be identified. The second case was analyzed by constantly comparing results to results from the first case; emerging new categories and subcategories were added to the list of tentative categories. After creating tentative categories for each of the five cases, the researcher integrated the initial categories, subcategories, and descriptions emerging from the data (Appendix M), which were used for final category formation. After analyzing and comparing the five cases based on the coding scheme, the researcher noted patterns based on research questions.

Validity and Trustworthiness

Consistent with Merriam's (2002) strategies for promoting validity and reliability, this study includes a thick description of the context of the study, a detailed account of the process of data collection and analysis, triangulation through multiple data sources (Denzin, 1970), and maximum variation via diversity in purposeful sampling. Peer checking with two other researchers was employed to promote reliability and to obtain consensus for open codes and tentative categories from the data analysis for each of the five cases.

Findings

What strategies do preservice teachers use and develop for Web-enhanced CBR activities?

Figure 4.3 illustrates the strategies preservice teachers developed during Web-enhanced CBR activities. The structure of the course project represents the natural process of "doing" an activity (i.e., a unit of experience, including scenario work, case analysis, planning, doing, and reflection), although it was not always distinctly identified in projects or by participants. Within this structure, four strategies were identified: automatizing, analyzing, articulating, and interweaving.

Automatizing. Automatizing was identified when the participants made intuitive decisions based on their preferences, pre-determined goals, and relevant experiences without planning. Participants often decided project scenarios intuitively, including the subject matter and target grades of the lesson plans. The use of preference and experience was a common automatizing strategy, presenting itself differently across cases.

Use of preference was observed when participants identified target student populations and subject matter for their course projects. All participants decided on target grades for their CBR projects at the beginning of the semester. The main reason that the preservice teachers gave for selecting their target grade student populations was the expectation of teaching those grades in the future. For example, Stephanie decided to develop technology-enhanced lessons for 3rd-grade students for all course projects from the outset of the course because she planned to teach at this grade level in the future. Alex typified this pattern in her selection of elementary resource students in 2nd to 5th grades: "I decided on resource students because that is what I want to teach." In the Inspiration project, she selected 5th-grade resource students because she had positive perceptions through her volunteering experience: "Fifth grade, really like the grade that I want to teach….But also, last year I did have a lot of fun with the 5th-grade resource class." Liz and Carrie decided their subject matters because they liked them. Liz opted for social studies, specifically African geography, for her Inspiration project because she wanted to teach and learn it. In the second interview, Liz recalled learning the geography of Europe, the United States, and Asia, but not of Africa: "I really love social studies, and that's what I want to teach. And I really love geography, and so when I looked at the QCC standards, and I don't know why, but Africa just sort of intrigued me because I haven't really learned that much about it." Likewise, Carrie selected middle and high school political science for her Inspiration project, social studies for her PowerPoint game, and history for her WebQuest—her "favorite" subjects, she recounted.

Use of personal experience was evident when participants identified specific topics and rough lesson structures based on their experiences; all participants selected one or more specific topics for their projects based on their personal encounters, including K-12 learning as a student, other course work, their own teaching, and observation of other teachers' classrooms. Cindy and Stephanie decided specific topics based on non-technology courses that they considered as positive. According to Stephanie:

> …in 6th grade I remember we toured places in Atlanta, like downtown Atlanta and historical places and stuff, and that was really fun, and now I know where stuff is

and what goes on there. So, I thought it would be good even for a 3rd-grade class. (Third interview)

During the Inspiration project, Liz re-used the content from a previous course, recalling information similar to the current course project. In the second interview, she addressed the similarity between the previous and current projects: “It was a similar topic, the same topic I taught or what we did in class, but I really didn’t do anything the same. So, besides the blank map of Africa, that was the same, but everything else was different.” During the Inspiration and WebQuest projects, Alex also recalled problems as a substitute teacher when the regular teacher did not provide lesson plans for her to follow. She recounted, “I’m sure they didn’t learn anything that day, which is unfortunate.” However, when she finally read the book *Superfudge* to the students, she found that the students enjoyed the story very much: “Actually, I got my idea from when I was subbing and I was reading a book to a class, and I was like ‘I could do a little story on this.…”

Preservice teachers selected subject matters and students for projects at the beginning of each project. Automatizing led them to define the scope of their projects. For example, Cindy started by deciding a subject matter for predetermined target grades: “I tried to decide what I wanted to do, like with my WebQuest, or at least a subject, and so I think overall during the semester I’d been concentrating on 3rd grade.” Automatizing also allowed preservice teachers to have a chance to assess their project situations where they encountered unexpected difficulties because of their limited understanding of the characteristics of the project, particularly software programs, at the time of their decision. They evaluated their decisions based on target grades or subject matters and the characteristics of programs. For example, Cindy considered her PowerPoint game to be more appropriate to mathematics than the current subject matter, social studies, in that the "timer" component would be more effective for calculation. Alex also addressed her decision to use a WebQuest for 2nd-grade students as "a bad choice" because she realized that it was difficult to find appropriate Web resources for 2nd-grade students and because she thought a WebQuest would require students' learning ownership. She decided that older students would be a more appropriate audience for learning with a WebQuest:

> …I think it was a bad choice (laughs). I think it would have been easier if I had done an older grade, but I guess I started thinking I wanted to teach the younger elementary school kids, so I figured I do something I would actually do. But it would have been a lot of easier if I'd done older kids.... (Alex's third interview)

Analyzing. According to the Merriam-Webster Dictionary, the word *analyze* is defined as "separating or distinguishing the component parts of something (as a substance, a process, a situation) so as to discover its true nature or inner relationships." In this study, analyzing was identified when the preservice teachers distinguished among concepts related to their project situations. All participants used analyzing strategies to understand teaching with technology contexts, characterizing and comparing concepts across the situations.

Characterizing strategies were observed in different stages of the course project, including scenario work, case analysis, planning, and doing. During scenario work, all preservice teachers decided their projects by focusing on particular components of their scenarios. For Stephanie's selection of Kidspiration for her 3rd graders, she determined that the characteristics of the program (e.g., plentiful pictures) were more suitable to her students' motivation than text- or shape-intensive programs: "...the pictures are more kid friendly and it is much … easier for them to understand." In addition, while 4 of 5 participants used Inspiration's webbing function, Cindy identified ways to link to Web resources for students' research. Because of her prior experience using Inspiration as a webbing tool for brainstorming ideas for lesson plans, she focused on new applications: "I didn't want to do that, because I knew how to do that. And so that's why I did the linking part of Inspiration." As a result, she analyzed the characteristics of hypertext functions to enable users to link to Web resources as the focus of her course project.

Characterizing was also observed after participants described their scenarios for course projects. During case analysis, all preservice teachers studied the expert video cases characterizing teachers' roles, pedagogical methods, pedagogical affordances of technology, and students' reactions and motivations. For example, Alex weighed the benefits (e.g., better for special education students) and limitations (e.g., assessment) of group work pedagogy. She also described students' reactions and motivations for computer use:

> She [the teacher] kept them [students] confined to one computer and working as a group because, being special ed, they tend to [get] lost in a large lab….She was very careful to make sure that the students felt encouraged by the use of technology rather than intimidated. (Alex's Inspiration CBD report)

All preservice teachers, however, tended to write broad descriptions of teachers' video cases in their "Critique," which allowed them to describe their points of view rather than simply providing case summaries. While the writing in "Story summary," "Technology integration," and "Potential of the software program" indicated situated descriptions in case situations, writing in the "Critique" section provided fewer specific details. For example, Stephanie wrote a case analysis for Inspiration, focusing on the general characteristics of special education students without specifically relating them to the Inspiration program:

> Some weak points are that it is a bit much for say a special education child to do on his or her own (usually), but at the same time, it is easy enough that if the children were shown how to use it properly most could. (Stephanie's Inspiration CBD report)

Carrie also wrote about general benefits from computers, rather than specific situation descriptions in the cases. While she acknowledged that teachers' cases helped her to understand the nature of her Inspiration project "to make a web," her written case analysis focused on general benefits:

> I definitely see some strong points in using inspiration [*sic*] in the classroom. It creates a different way for kids to learn, and it also exposes them to computers. Computers seem to be the way of the future and the sooner children are exposed to it the better. Computers are used throughout your school career and in the workplace. (Carrie's Inspiration CBD report)

Comparing strategies were observed mostly when preservice teachers utilized ideas from expert video cases, Web resources, and examples. All participants organized their ideas, documenting ideas from the cases and comparing the experts' cases with their own projects. For example, Alex compared students' grade levels and motivations with teachers' video cases as she developed her Inspiration lesson. She used group work, the focus of her case analysis, as the main pedagogy in her project. Additionally, she used Inspiration for "pre-reading skills":

…in the end we will come back together to create the "super web" by combining each group's smaller web. This would be done by me using a projector which is similar to Theresa's [expert teacher] method of teaching. Another similarity is that the basis of the webs is a story that the class reads. (Alex's Inspiration CBD report)

Liz contrasted her Inspiration project situation with the expert case because it dealt with a low-enrollment, special education classroom:

I plan to teach in a mainstream classroom and so I will probably have more students. For this reason, I want my students to work in pairs in order to gain a better understanding of the material and to help each other locate specific topographical features and define them. (Liz's Inspiration CBD report)

Comparing strategies were also used when participants searched for specific examples of the content or subject matter to be taught. While searching for a project situation with examples, such as topics, grade, and curriculum standards, Stephanie stated:

I was just really looking to see what they had going on just to see if anything matched what I was looking for, and it really did match pretty good like…they were talking about communities and stuff like that and it was under 3rd grade, and so it seemed it was part of their curriculum. (Stephanie's second interview)

Articulating. In the Merriam-Webster Dictionary, definitions of "articulate" include "to unite by means of a joint" and "to form or fit into a systematic whole." Articulating was evident when participants detailed activities for their lesson plans and materials. Articulating strategies were used by participants to integrate their analyses with other examples into their lesson plans and materials. All participants envisioned implementation because they were asked to create the lesson plans or materials, including detailed student activities. When preservice teachers considered the feasibility of their plans and materials, they focused on whether their lessons would work and their students would be motivated to use them:

> I think I spent the most time working on steps in lesson plans. I'm just really trying to picture how it would go and what it would look like so I could possibly, potentially save it and bring it back out and use it in the future. (Liz's second interview)

Cindy envisioned detailed pedagogies in her lesson plans: "I did think more about my lesson plans and how I was going to use it." Carrie checked the clarity of her activities by rehearsing and reading aloud before her friends. As a result, she attempted to simplify the lessons and materials so the target students could follow the activities readily.

All participants collected ideas, examples, and materials to construct their own lesson plans and materials. Their sources included Websites (e.g., state curriculum Websites for teachers, gateway sites for educational resources), textbooks, and teachers' video cases. Cindy, Liz, and Carrie used various examples to design detailed lesson plan activities. The participants typically adapted specific ideas rather than adopting whole structures:

> I spent most of my time finding the information than actually building the web. And then after the organization of it, like making it so that you knew what parts were supposed to fit together, I think that's what I spent the most time on. (Carrie's second interview)

Cindy recounted her prior planning experiences, having already generated lessons using a database of other teachers' examples and ideas, and continued to do so during CBR-scaffolded planning and development activities. After deciding a scenario, she sought options to detail her lesson plan by searching for corresponding examples in her database. Carrie also sought examples of teachers making a web, describing this as seasoned teacher know-how: '"Don't try to reinvent the wheel, borrow things from others and so that's important I think."

Liz, however, encountered difficulty integrating others' ideas and examples into her lesson plans. For example, despite spending most of her time finding examples and ideas for lesson materials on the Websites, Liz described her approach to her Inspiration lesson and material development as trial and error. She later stated she had too many ideas for her plan, and she experienced similar difficulty selecting a topic for her WebQuest.

*Interweaving***.** Between doing and reflection, all preservice teachers *interwove* the course projects into new situations, such as other coursework, student teaching, and future classrooms. Interweaving strategies were observed when participants identified lessons learned from their current CBR experiences and possible solutions for future projects. Participants identified their lessons about individual project efforts and about technology itself. Carrie suggested that sharing feedback helped to clarify lesson plans and Inspiration materials, adding that lesson plan organization should be clear if the lesson plans are to be shared effectively. Alex evaluated project scenarios according to student characteristics and domain content, proposing new potential application situations, such as a higher-grade level and different subject matter. Liz proposed a balance between thinking and developing to reduce the number of potential ideas before developing lesson plans for her next project:

> The only difficulties I encountered were, one, coming up with an original idea. I had too many of them and was overwhelmed at my possibilities and which one to

> choose. If I was [*sic*] re-assigned this project, I would just pick an idea and go with it. I would not spend so much time laboring over which idea to do and creating the whole scenario and game in my head before I created the game. (Liz's second interview)

Related to technology, Carrie addressed how to enhance multimedia functions for her next PowerPoint project. Following peer feedback, she noted that her partner's game had many animated objects and perceived it as more interesting than her own game: "If I were to do this project again I would have made the game a little bit longer and have added more sound and animation." Stephanie identified timeline issues in her Inspiration lesson plan: "It said it is for six days, I probably would only make it for five days because over the weekend they are going to forget." Alex identified the need for effective and clear concept maps:

> The biggest problem I had with the Web was trying to make it all fit onto one page so that the students would still be able to read it. There were so many parts to the Web and then quite a bit of information to branch from each main idea that it got cluttered very quickly. I think the best way to remedy this problem would have been to use the tool that creates notes for each of the elements of the story rather than creating a new bubble for everything. This would help to make it much more organized and easy to read. (Alex's Inspiration CBD report)

Interweaving was also identified when participants indicated they planned to apply (or had already used) their knowledge and skill in situations outside of the course. All participants perceived the course projects as being "useful," indicating that they would draw on their experience subsequently either in "other coursework" or their "future" classrooms. For example, Liz noted that she would use the technology programs for other coursework, but pointed out that use in schools would only be possible when access issues could be resolved. Cindy planned to use technology for her future classrooms and anticipated applying for the certificate programs for technology integration offered by the college: “It sparked my interest in thinking of ways I can use this in my classroom and seeing the importance of it and how it can be used.”

Carrie and Alex applied their course knowledge and skills during their pre-teaching experiences. At the end of the semester, Carrie suggested that her cooperating teacher use a PowerPoint game, and she developed and implemented a new game using her course project template. She reported being nervous before the implementation of the new game and was concerned that its structure was too simple to motivate students. However, she recounted deeper understanding in “how to develop and use” PowerPoint games in terms of students’ ability and involvement: “I don’t think it would have been as much fun, because they would have had to think too much about it instead of concentrating on their review questions.” Alex’s experience as a substitute teacher allowed her to critically think about technology use in classroom situations. She believed that lessons would be improved if technology were used where she observed and taught, and she noted whether or not computers were present in the classrooms she visited. Alex also encouraged her mother and another teacher to use her PowerPoint game.

How do preservice teachers use the structure and components of the Web-enhanced CBR activity?

Web-enhanced CBR learning activities were designed to provide authentic tasks and activities, along with scaffolded expert cases for teaching with technology. All participants acknowledged that Web-enhanced CBR activities were helpful in learning about teaching with technology and perceived course projects as realistic teaching tasks. Web-enhanced CBR activities were used by preservice teachers as both a framework and a catalyst to learn about teaching with technology.

Used as a framework. Web-enhanced CBR activities helped participants to generate plausible classroom contexts for teaching with technology by scaffolding their deliberations. Course projects (e.g., microteaching and technology-enhanced lesson plans and materials) can prove complex and ill-structured tasks for preservice teachers who lack teaching experience; Web-enhanced CBR activities helped participants to identify and use contextual components (e.g., where, who, how, and why) and critical concepts and perspectives (e.g., roles of technology, teachers' roles, students' characteristics, and pedagogy) for their projects.

Case-based doing tool templates prompted 3 of 5 participants to consider critical and complex concepts for teaching with technology. Liz, Carrie, and Stephanie indicated that writing in CBDT helped to organize their journaling, reflection, and brainstorming; they completed each section before or during the activity and used the tool to draft their ideas. Liz used CBDT writing as "background" to identify what she was going to do and why. Carrie used CBDT writing to think comprehensively as she expressed concerned about missing important information:

> I think it helped because it is almost sort of like a pre-write; you are getting ideas out that maybe you wouldn't have before and it kind of prompts you, kind of gives you these guidelines and you're like, "Oh, I might have forgotten that" if you didn't say who your target students are. I mean, you might not think to tell someone

> because you know what it is. Everyone else doesn't know. I think it is a good way to organize ideas before you get started in on the project. It helps ideas flow. (Carrie's second interview)

Cindy and Alex, on the other hand, mainly used the CBDT after developing their projects to reflect rather than to initially formulate their ideas. Alex perceived the planning section to be useful in forcing her to consider the "big picture" of her project, but described it as being tedious and unproductive and not contributing to the "production" of lesson plans and materials. Similarly, while Cindy acknowledged the effectiveness of the CBDT, she indicated it did not "fit" her style of first developing, and then continually changing, her plans. Based on her prior experience, Cindy already developed a strategy for lesson planning and teaching, thus, she viewed CBDT documentation as adding to her workload rather than facilitating her thinking.

All participants used the expert teachers' cases to frame how technology programs are used in everyday classrooms. They analyzed or adapted the expert teachers' ideas as they constructed their own lesson scenarios. Teachers' video cases, however, were not used specifically to detail their lesson plans. Instead, they provided authentic contextual referents for introducing the programs and demonstrating their classroom uses:

> They gave me a good idea of how they used it and how the students reacted to it. It kind of gave you the teacher's mindset and the students' mindset of how they liked their project, which was nice before you go into a project—how are the students going to perceive this? Like in this case, they liked it or they weren't sure about it…and if they were, how could yours better than hers? Or keep what she had, because that's something that they liked. (Cindy's third interview)

Peer review and the instructor also helped 4 of 5 participants to frame their lesson scenarios. Cindy, Alex, Carrie, and Stephanie used peers' suggestions to revise their course projects. Conversations often clarified ideas and refined technological functions for their instructional materials and led participants to consider specific factors, such as students' motivations and abilities, feasibility of timeline, and representation of content. For example, during Stephanie's discussion of the test strategy for her Inspiration lesson plan, she focused on educational roles of technology (e.g., "time consuming" and "easier"), understanding students' characteristics (e.g., "fun" and "better understand"), and the teachers' role (e.g., "help"). Her partner's feedback helped to frame her lesson:

> I was just going to print out a blank thing and just have some of the pictures. But she said that it might be a little more time consuming, but if there are computers available, it would be easier for them to beat on the computer and would think of it more as fun than as a test and they wouldn't stress out about it. They would do better and understand better because they would be hands-on again. And plus, I'd be there to help them if they had trouble. (Stephanie's second interview)

Liz, however, did not use her partner's suggestions for her first lesson plan, noting: "I think I would have rather spent that time working on my project than looking at someone else's." She stated that her lesson plan was her own idea. In the second interview, Liz attributed her negative reaction to peer review to her independent personality.

The course instructor assumed the role of a model and coach, introducing the project, demonstrating how to use technology programs, helping with technical support, and providing individual advice. While participants perceived the instructor as accessible to address problems and questions and used the technical support for developing instructional materials, they frequently used Web resources (e.g., GLC Websites) to find examples for course projects. According to the post study, the instructor differentiated her role in CBR projects from her role in other classes. She shared conversations with preservice teachers, focusing on lesson development not limited to technology support: "I did get to help them brainstorm ideas for their lessons and help them expand on lessons and that kind of thing that I didn't get to do in the other classes."

Used as a catalyst. As a catalyst, the Web-enhanced CBR activity stimulated understanding of exemplary practices for teaching with technology. Participants' lesson plans and activities related to computer use reflected knowledge and skills beyond their initial simplistic understanding. Web-enhanced CBR activities provoked preservice teachers (1) to develop a new orientation toward the importance of technology and how to use it and (2) to transition into the culture of everyday teachers.

All participants reported initial perceptions of technology's role in teaching, but technology was not integral to their perceptions of the typical classroom. Therefore, while they initially believed that the goal of the course was to learn a variety of programs, few indicated how technology would be integrated with teaching. Teachers' cases, CBDT, and peer review stimulated a shift of participants' orientations to teaching with technology:

> I felt like it taught me a lot about how to integrate technology in a classroom and how to be comfortable with it…like I'd never dreamed to do a PowerPoint game for a review. I wouldn't have thought I could create something out of PowerPoint. (Liz's third interview)

Specifically, the instructor reported that teachers' cases helped preservice teachers to relate technology to classroom teaching: "But as far as making that connection, I feel like the CBD students have a better chance because they've seen examples of how teachers use it." The instructor also mentioned that she could "do a better job of addressing the use as opposed to just the discreet skills" with preservice teachers in CBR projects.

Web-enhanced CBR activities also facilitated the transition of novice, preservice teachers to the culture of practicing teachers. Participants gained initial experiences and practical insights related to teachers' pedagogical practices, lesson planning, and material development. During the instructor's interview, she acknowledged influence of the CBR projects to preservice teachers' participation in teaching practices: "I would guess the CBD students would call on it because they are already used to think[ing] about an objective and how technology might help to address that particular learning objective." For example, Carrie had neither prior teaching nor lesson planning experience, which she described as "a blank slate." CBR-scaffolded course projects, therefore, provided a formative apprentice in the culture of practicing teachers. Carried noted, for example, that sharing lesson plans is a common practice of teachers and that teachers share them through the GLC Website; she also practiced sharing via peer review exchanges with her partner: "I learned that there are things out there like that, like teachers just don't make up everything on their own." Cindy and Liz used Web-enhanced CBR activities to hone their pedagogical uses of technology. They used CBR activities to consider the characteristics of different lesson situations for computer use.

> The course has helped me get better at lesson planning and being aware of what each grade level needs and how I can incorporate and use technology in different ways, and like I can change it, like an Inspiration project to a 6th-grade level

Inspiration project, like the same thing but done in a deeper…higher academic level. (Cindy's third interview)

Discussion

In the CBR framework, expert strategies provide the "know how" for solving problems and completing tasks (Collins et al., 1989)—strategies that novices typically lack. While experts routinize, reflect upon, apply heuristics, and collaborate (Brown et al., 1989; Collins et al., 1989; Greeno 1991; Greeno et al., 1998; Lave & Wenger, 1991) with other experts, novices are typically unable to do so effectively due to limited teaching experience and the resulting lack of situated knowledge and skill. The current study indicates that preservice teachers automatize, analyze, articulate, and interweave their understanding with experts' knowledge and skill as they initiate their transition and acculturation to the practicing teaching community.

Automatizing, apparent during *scenario work,* is a natural reasoning process of both experts and ordinary people, wherein individuals quickly retrieve and use existing knowledge to address new demands (Schank 1999). Unlike with preservice teachers, expert teacher knowledge becomes increasingly routinized through repeated experiences, providing rich case knowledge (Greeno, 1991; Leinhardt & Greeno, 1986; Perkins & Salomon, 1989). Expert teachers also retrieve relevant cases from rich experiences, automatically and readily identifying similarities and differences between new and old cases. During these processes, experts conduct an initial situation assessment for their new task (Kolodner et al., 2004). Like experts, preservice teachers automatically retrieved and applied their case knowledge for scenario development, but their automatizing strategies did not reflect deep contextual understanding. Their automatizing typically reflected existing, intuitive beliefs, mostly based upon preferences, positive past experiences as a student, and expectations for similar result. While experts access relevant case knowledge during their initial situation assessments almost unconsciously (Schank, 1999), preservice teachers in this study used cases, often nonspecifically matched cases, that were based more on their intuitive perceptions than on situation assessment. Expectation failure was evident during lesson planning and material development when their assessments failed to address current situational demands. While their initial automatizing strategies proved problematic, iterative trial-and-error refinements helped preservice teachers gain “know-how” for future practice (Schank, 1999).

Practicing Web-enhanced CBR activities across a succession of scenarios helped preservice teachers to improve their initial situation assessments. Whereas initial judgments and decisions were based largely on personal preferences and limited experience, Web-based CBDT templates scaffolded their reasoning to underscore key technology integration processes. Initial naive assessments became increasingly sophisticated as preservice teachers described their project scenarios based on holistic components (e.g., target students, curriculum standards, content).

Preservice teachers analyzed while planning and developing lessons and materials to better understand conditions for teaching with technology. Lesson planning and material development for teaching with computers were unfamiliar activities for preservice teachers. When experts encounter unfamiliar problems, they apply general principles or heuristics to assess the situation and identify plausible solutions (Clement, 1991; Schank et al., 1999). Although preservice teachers’ heuristic strategies were not discernible in this study, they used their knowledge about particular concepts, such as teachers' facilitation roles, constructivist pedagogy, and students' characteristics, for case analysis and planning as the study progressed. For example, Stephanie's project situation assessment addressed her target students' characteristics, and she applied the general principle of increased visualization for younger students to her lesson planning and material development. Analyzing, therefore, may become useful as novices attempt to cope with complex events, allowing them to engage situations and model actions within defined, scaffolded parameters.

Schön (1983) also suggests that when situations are ambiguous, it is helpful to make them precise. In this study, expert teachers' video cases and CBDT templates provided a framework to engage unfamiliar situations by providing prompts that highlight critical concepts and by enacting technology integration practices. Preservice teachers considered expert teachers' cases to be useful for understanding the context and for highlighting teachers' roles, pedagogical methods, students' characteristics, and educational characteristics of computers. However, they reluctantly engaged in detailed case analysis. This was likely because preservice teachers lacked deep understanding of the cases and did not recognize their relevance. Literature indicates that novices often fail to recognize the expert's insights and concepts (Chi, Feltovich, & Glaser, 1981), thus experience difficulty applying expert knowledge and skills to their own work (Owensby & Kolodner, 2002). Similarly, in this study, preservice teachers did not apply expert knowledge and skills to their course projects in specific ways. This finding is perhaps attributable to the different focus of the cases and the projects. Teachers' video cases focused on implementation of technology-enhanced lessons, while course projects focused on development of lesson plans and materials. When experts' cases are considered as analogs to preservice teachers' projects, the cases should contribute meaningfully because the advice is tendered by knowledgeable, virtual mentors (Kolodner & Guzdial, 2000). To increase case relevancy, teachers' stories about developing lesson plans, the focus of the course project, should be provided along with the cases about implementation. In addition, providing multiple, well-indexed cases might increase the prospect of identifying cases relevant to the various scenarios defined for individual course projects.

Preservice teachers also considered the CBR scaffolds as a framework to identify key factors they might otherwise miss. They perceived the scaffolds as comprehensive rather than as precise. Clearly, the motivation of different participants influenced their participation and use of CBR scaffolds, as well as perceptions of their utility. Liz, Carrie, and Stephanie, for example, noted that writing in CBDT facilitated their brainstorming and organization of thoughts before development. Other participants considered writing in the CBDT to be separate from, rather than integral to, lesson plan and material development. When participants focused mostly on production and completion of their projects, they tended to ignore reflective thinking in action, which has been identified as a characteristic of experts (Schön, 1983). Cindy, for example, noted that implementation was more important than preparation. Alex perceived writing her plan as unproductive, and Carrie noted that technology planning increases teacher workload. However, it is important for preservice teachers to learn to reflect on, rather than simply implement, teaching practices, as exemplary teachers tend to allocate more time to planning and decision making than do new teachers (see, for example, Pierson, 2001; Russell et al., 2003). According to Chisholm and Wetzel (1997), deliberate planning, access to resources, and technological competence are needed for exemplary technology use.

Articulating strategies became increasingly apparent in preservice teachers' lesson planning and development. They envisioned implementing their lesson plans and collected information in order to integrate individual ideas into whole lesson plans and materials. Envisioning during development is typical of experts, who tend to think simultaneously by assembling principles to explain and predict events (Brown et al., 1999; Collins et al., 1989; Schank, 1999; Schön, 1983). Similarly, expert teachers anticipate how a planned lesson will be implemented (Westerman, 1991). Although preservice teachers had no opportunity to test their lesson plans in authentic classrooms, they deployed expert-like acting and thinking strategies during Web-enhanced CBR activities. The CBR activities required contextualized products as coursework deliverables and provided authentic tasks along with expert teachers' implementation cases. Thus, preservice teachers had multiple opportunities to situate their thinking, planning, and development in real classrooms.

Case-based reasoning activities also introduced preservice teachers to the teaching-with-technology community, helping to transition them to the social practices and values of professional teachers. Information and examples (e.g., textbooks, other teachers' examples, and Website information) were frequently collected and shared during lesson planning and material development. Peer feedback was employed to refine lesson details. When sharing feedback, participants talked about their products, clarifying activities and sequences and offering suggestions for improvement. Sharing dialogues about practices is typical in communities of practice (Lave & Wenger, 1991). When conversations emphasize practices for teaching with technology beyond basic technical functions, preservice teachers may learn how to talk and how to negotiate using the socially shared conventions of the community (Brown et al., 1989).

According to Schank (1999), knowledge develops when individuals identify important ideas and re-index their overall understanding accordingly. In this study, interweaving occurred when preservice teachers noted lessons learned and indicated their intent to apply their course knowledge to new situations. Although some preservice teachers identified lessons learned and possible future applications via the CBDT, their applications tended to be shallow and non-specific. Not surprisingly for preservice teachers, they documented their perceptions using short descriptions of expectation failures, suggesting that deep understanding had not emerged.

Experts also draw upon rich experiences, which they readily apply to new situations (Brown et al., 1989; Perkins & Salomon, 1989; Schank, 1999). In this study, interweaving strategies focused mainly on anticipated situations outside the course or beyond the current semester. Only two participants, Carrie and Alex, applied their project ideas during the current semester. This was likely because the length of the semester was not sufficient to experience applications of their learning to new situations. Although all preservice teachers perceived the projects as being useful and described confidence and willingness to use them in the future, research suggests that confidence and positive attitude toward teaching with technology are not universally correlated with future classroom use of computers (Russell et al., 2003).

Conclusion

This study suggests two implications for design and research of Web-enhanced CBR learning environments. First, scaffolding strategies during Web-enhanced CBR should be considered for both design and research. While preservice teachers demonstrated some expert-like strategies during Web-enhanced CBR activities, the depth and quality of their strategies differed from experts' strategies. Preservice teachers lacked the in-depth understanding and rich experiences of expert teachers and tended to rely on their intuitive beliefs and limited experiences. In this study, the cases provided exemplary practices and contexts, but were limited in providing project-specific advice while writing in the Web-based CBDT; conversations with the instructor and colleagues provided real-time, ongoing guidance. While Web-enhanced CBR activities require ongoing guidance, it is unclear precisely how it should be provided. Research is needed to examine optimal balance and interplay between "live" and fixed scaffolding strategies during Web-enhanced CBR.

Next, participation in community-based social practices is fundamental to situated learning perspectives (Brown et al., 1989; Lave & Wenger, 1991). Preservice teachers had opportunities to participate in social practice through case analysis, peer reviews, and conversations with the instructor; case discussion was especially important to promote conversations between mentors and novices (Carter, 1989). Whereas the instructor often mentors by providing community wisdom and liaisons to interpret expert teachers' practices, in this study, analysis often focused on independent written work. As part of case analysis, case discussions between the instructor and preservice teachers should be examined in CBR activities to determine whether preservice teachers can develop in-depth understanding of expert practices and apply experts' experiences more richly to their own efforts.

Web-enhanced CBR learning has the potential to support preservice teachers' situated learning in university classrooms. While using CBR increases efficiency, it also requires time and effort for reflective thinking. Through writing in the CBDT, preservice teachers may learn how to apply their own and experts' experiences and how to assess situations, but further research and development are needed to refine our understanding of CBR's potential and pitfalls for both discrete and sustained learning.

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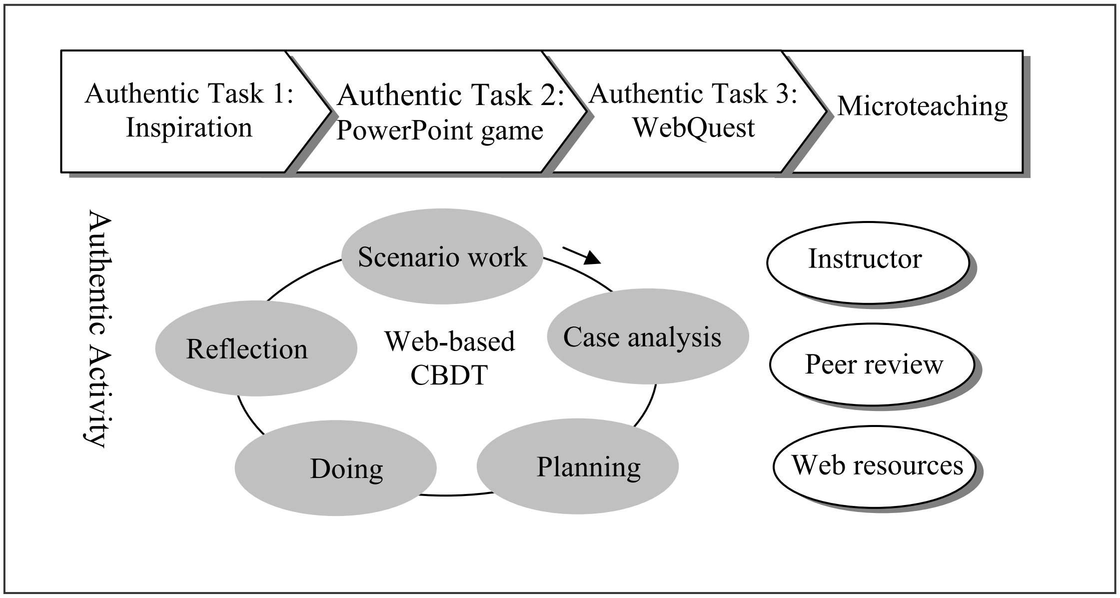


Figure 4.1. The structure and components of Web-enhanced CBR learning.

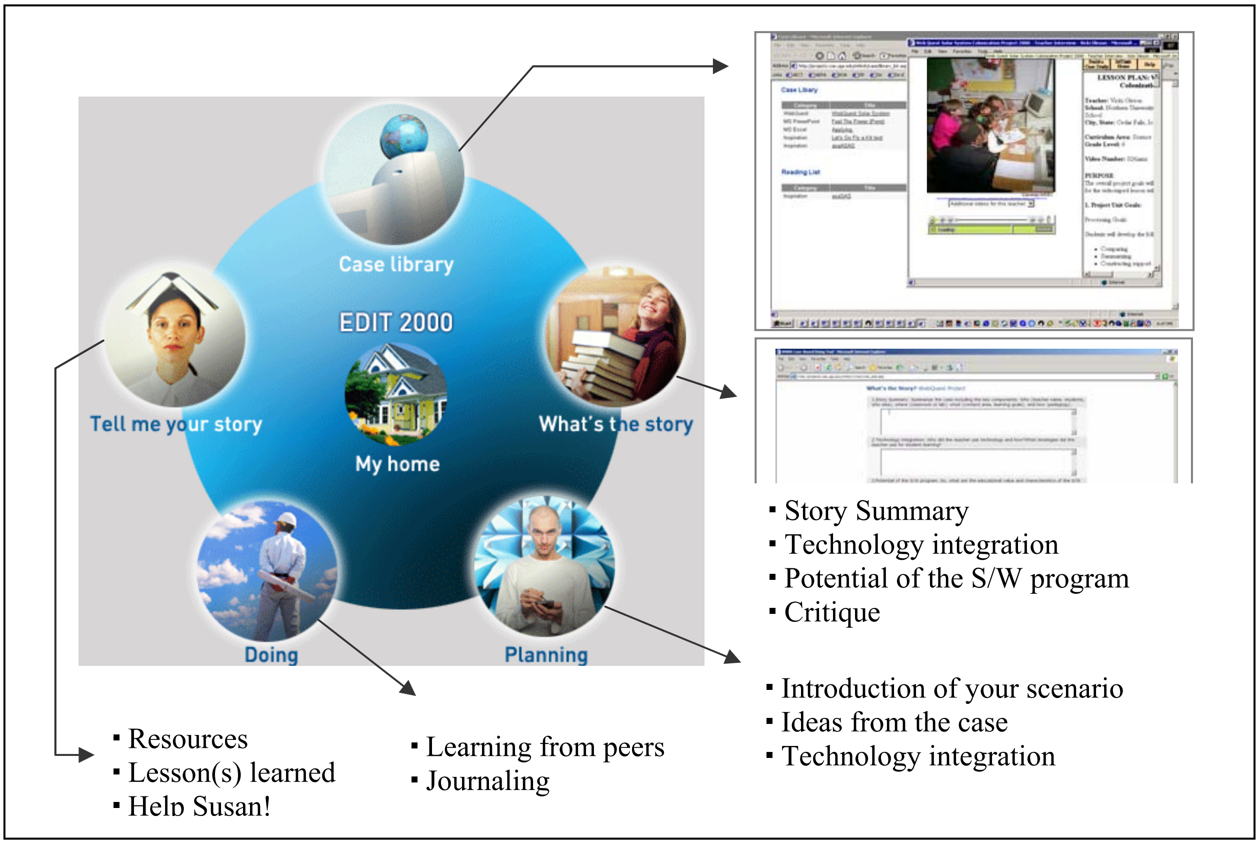


Figure 4.2. The screen shot and template structure of the Web-based case-based doing tool (CBDT).

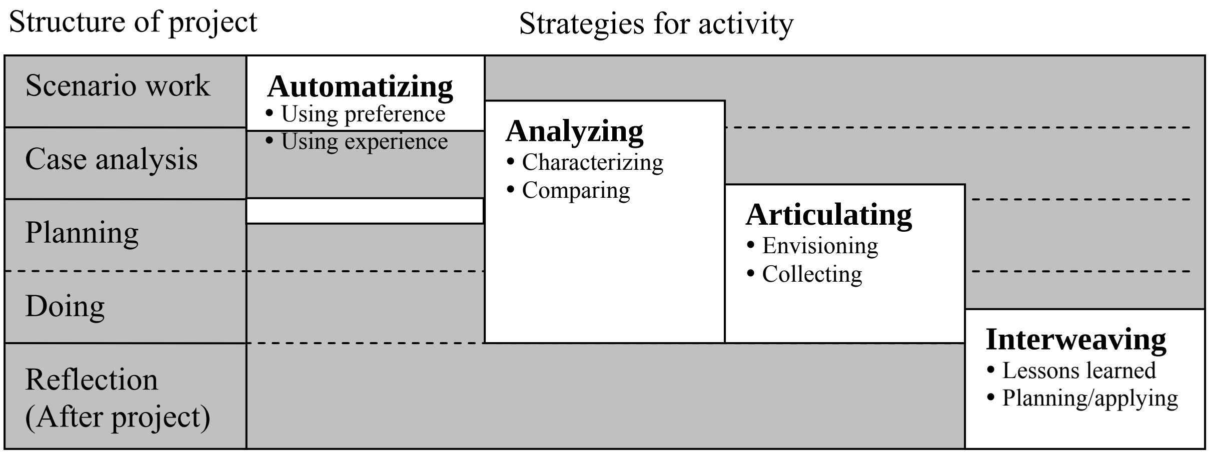


Figure 4.3. Preservice teachers' strategies for Web-enhanced CBR activities.

Note. The size of each square does not represent its frequency and importance.

EPILOGUE

This dissertation study presented a comprehensive investigation of situated learning with cases, including the conceptual framework, grounded design, and research studies. To this end, four chapters presented multiple areas of literature and provided implications for different kinds of audiences. The first chapter, *Situated Learning With Cases: A Model for Teacher Preparation*, proposed the conceptual framework to primarily explain teacher learning with cases from the situated learning perspective. This framework was used to design and develop the Web-enhanced CBR learning environment and to explain preservice teachers' learning during CBR in the later two studies. Because this framework presented comprehensive characteristics such as knowledge, skills, and beliefs from the situated cognition and learning perspectives, it also can be used in other research contexts, such as preservice teacher or novice learning, or in other situated learning approaches; the framework is not limited to case-based scenarios.

The second chapter, *Grounded Design and Web-enhanced Case-based Reasoning: Theory, Assumptions, and Practice*, presented the theoretical background and design principles of Web-enhanced CBR learning environments for situated learning with cases. This chapter introduced CBR learning examples in various areas to provide implications to broader audiences who are interested in technology-based or -enhanced CBR and constructivist learning environments. The grounded design practices in this chapter also can provide the methodology example of how researchers and practitioners interpret and apply theories for design of technology-enhanced learning environments.

The third chapter, *Learning to Teach With Technology: Developing Situated Knowledge via Web-enhanced Case-based Reasoning*, examined the development of preservice teachers' situated knowledge and beliefs in the Web-enhanced CBR learning environment over the course of a semester. The findings in this chapter indicated that preservice teachers changed their understanding during their interactions with authentic tasks and activities. Because this chapter focused on the community of teaching with technology, the results of this study can provide a detailed case study on preservice teachers' learning using a particular approach, which merits further study (Willis, Thompson, & Sadera, 1999).

The last chapter, *Web-enhanced Case-based Reasoning in Preservice Teacher Education: A Case Study*, presented an investigation of preservice teachers' learning processes in and interaction with the Web-enhanced CBR learning environment. Preservice teachers' learning processes in course projects were compared to expert teachers' processes in actual practice. The results of this study were used to understand preservice teachers' learning processes in similar teacher education programs. The study also has implications for the design of Web-based cases and CBR scaffolding tools to better learn expert teachers' strategies.

APPENDICES

Appendix A

Participant Profiles

Participant Profiles

Name	Age	Demographics	Major (Year)	Teaching/lesson plan experience	Initially perceived technology skills
Cindy	21	European-American female	Early childhood Education (3rd year)	Yes/Yes	-Skill: 3~4 (out of 10) -Confidence: Low
Liz	21	European-American female	Middle school education (4th year)	Yes/Yes	-Skill: 6 (out of 10) -Confidence: High
Alex	19	European-American female	Plans to apply to Special education (2nd year)	Yes/No	-Skill: 5 (out of 10) -Confidence: Medium high
Carrie	20	European-American female	Plans to apply to Special education (2nd year)	No/No	-Skill: 2 (out of 10) -Confidence: Low
Stephanie	20	European-American female	Early childhood education (3rd year)	No/No	-Skill: 5 (out of 10) -Confidence: Medium

Individual's Brief Results (Chapter 3)

Research questions	*How does understanding about the educational roles of technology change through Web-enhanced CBR*?			*How does understanding about teaching with technology develop during Web-enhanced CBR?*			
Major results	Perceived simple roles	Emergent understanding	Acquired potential for diverse roles	Perceived basic concept(s)	Emerging concepts	Varied concepts	Vestigial/extinct concepts
Cindy	Productivity/ Extra for learning	Productivity/ Extra for learning	Productivity, motivation, learning content and thinking skills / Helpful for learning	Teachers' roles pedagogy, technical issues	Students' characteristics, curriculum standards, content	Teacher's roles, students' characteristics, pedagogy	Curriculum standards, content, technical & access issues
Liz	Productivity, motivation/ Extra for learning	Productivity, learning thinking skills/ Extra for learning	Productivity, motivation, learning content and thinking skills / Helpful for learning	Teacher's roles, pedagogy, technical & access issues	Students' characteristics, curriculum standards, content	Teacher's roles, pedagogy	Students' characteristics, curriculum standards, content, technical & access issues
Alex	Productivity, motivation/ Extra for learning	Productivity, learning thinking skills/ Extra for learning	Motivation, learning content and thinking skills, communication/ Helpful for learning	Teacher's roles, pedagogy, access issues	Students' characteristics, curriculum standards, content	Teacher's roles, students' characteristics, pedagogy	Curriculum standards, content, technical & access issues
Carrie	Motivation/ Extra for learning	Motivation, learning thinking skills/ Extra for learning	Motivation, learning content and thinking skills/ Between extra and helpful	Teacher's roles, pedagogy	Students' characteristics, curriculum standards, content	Teacher's roles, students' characteristics, pedagogy	Curriculum standards, content, technical & access issues
Stephanie	Productivity, motivation/ Extra for learning	Productivity, motivation/ Extra for learning	Motivation, learning content and thinking skills/ Between extra and helpful	Teachers' roles, pedagogy, technical issues	Students' characteristics, curriculum standards, content	Teacher's roles, students' characteristics, pedagogy	Curriculum standards, content, technical & access issues

Appendix B

Course Structure

Course structure	Objective	Major activities/projects
Week 1: Introduction	Introduction of the course and computer technology	• Introducing the course and projects • Emailing the instructor
Weeks 2-3: Productivity Tools (Microsoft Office)	Use of Microsoft Office as a productivity tool and introduction of the Georgia Learning Connections (GLC) Website	• Developing seating charts (PowerPoint Game), business cards (Word), and attendance records (Excel) • Finding three lessons plans on the GLC Website • Writing 1-page integration statement
Weeks 4-5: E-portfolio (Dreamweaver)	Introduction of the e-portfolio	• Writing the introduction in the homepage of e-portfolio • Editing pictures using Fireworks • Uploading the e-portfolio on the server
Weeks 6-7: Web-enhanced CBR Activity I: Inspiration	Development of Inspiration-supported lesson plan and materials	• Watching the teacher's video case for Inspiration use • Developing the lesson plan for Inspiration use and the Inspiration materials as part of the lesson plan • Sharing peer feedback on products • Following the procedure of the project: scenario work, case analysis, planning, doing, and reflection by writing in CBDT
Weeks 8-10: Web-enhanced CBR Activity II: PowerPoint Game	Development of the instructional PowerPoint game	• Watching the teacher's video case for PowerPoint game use • Developing a PowerPoint game • Sharing peer feedback on products • Following the procedure of the project: scenario work, case analysis, planning, doing, and reflection by writing in CBDT
Weeks 11: Web Resources	Understanding of how to use web-based resources	• Finding five web resources in Marco Polo and other sites
Weeks 12-14: Web-enhanced CBR Activity III: WebQuest	Development of the WebQuest material	• Watching the teacher's video case for WebQuest use • Developing the WebQuest material • Sharing peer feedback on products • Following the procedure of the project: scenario work, case analysis, planning, doing, and reflection by writing in CBDT
Weeks 15-16: Web-enhanced CBR Activity IV: Microteaching	Implementation of the technology-enhanced lesson plan and completion of the e-portfolio	• Selecting and revising one of the CBR projects for 15-minute microteaching • Implementing the lesson plan in front of classmates (video-recorded) • Receiving all classmates' and the instructor's written feedback • Writing reflection based on watching the videotape and reading the feedback sheets • Writing and compiling all the projects in the e-portfolio

Appendix C

CBR Cycle and Web-enhanced CBR Activity

CBR cycle*	Web-enhanced CBR activity
New Case (Problem) ▪ Initially assess the new case	**Scenario Work(i.e., project)** Learners have their own scenario (i.e., project) so that they can know the initial image of the goals, tasks, and outcomes of the project.
Retrieved Case / New Case ▪ Retrieve cases (analogs) from the case library	**Case Analysis** Learners retrieve their experience relevant to the new project. If they do not have any, they use an expert teachers' case(s) in the external case library. They analyze the cases in terms of critical concepts and principles (e.g., pedagogical role of technology for technology integration classrooms).
Initially Solved New Case ▪ Assess the new case ▪ Propose a ballpark solution from the old case	**Planning** Learners use case ideas and concepts by comparing between expert teachers' cases and their own projects in terms of commonality and difference. Learners propose their plan (i.e., solution) for the project.
Learned Case ▪ Adapt the ballpark solution to the new case ▪ Criticize the solution ▪ Store the learned case	**Doing** Learners implement their plan (e.g., developing a lesson plan and an instructional material) with ongoing reflection. **Reflection** Learners reflect on their project so that they can tell their story and lessons learned and practice transfer of their learning.

**Note.* Adapted from Aamodt & Plaza, 1994; Kolodner, 1993

Appendix D

Sample Inspiration Lesson Plan and Instructional Material

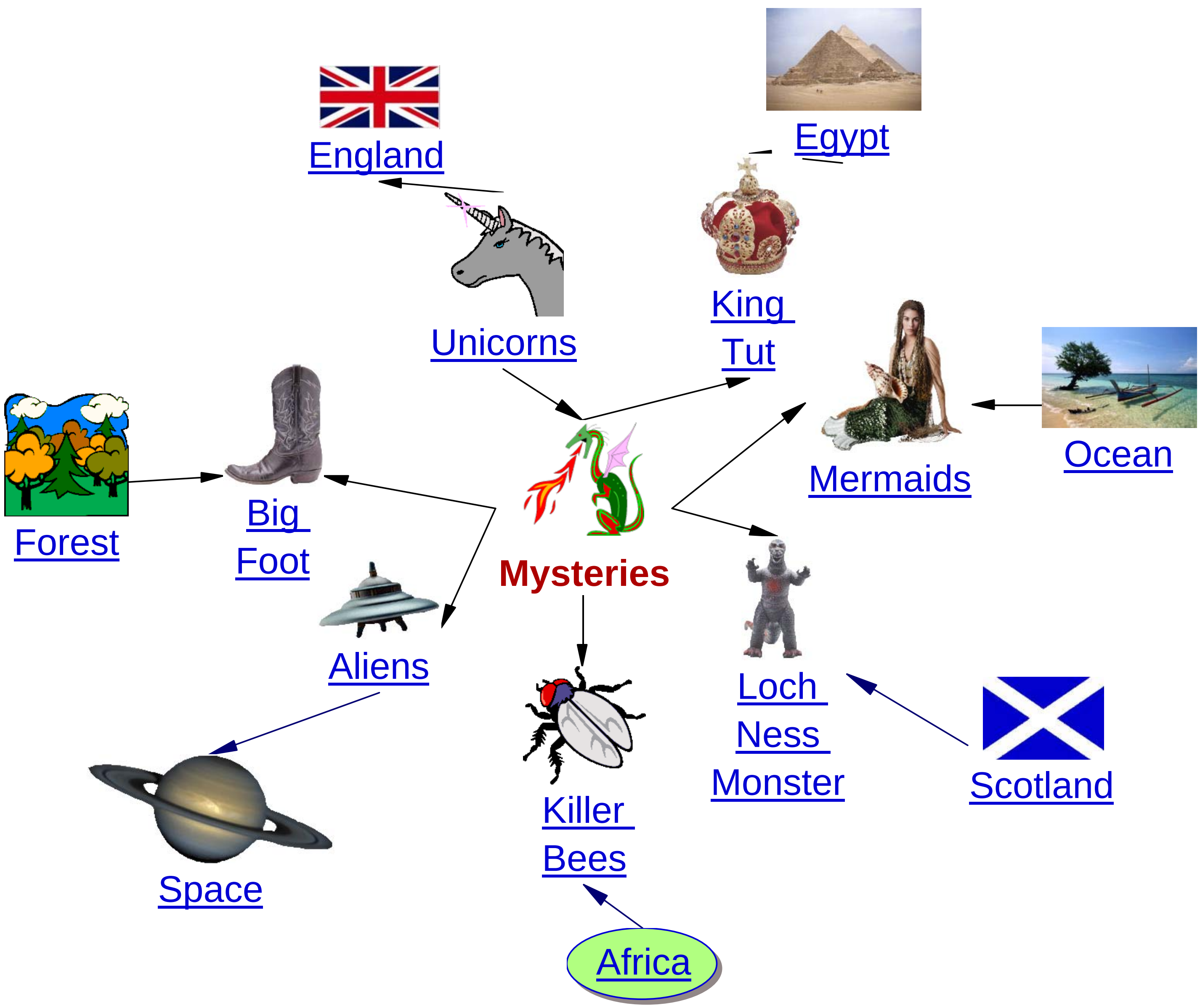
Lesson Plan for Mystery Unit

Teacher:
Grade: Third

Activity Title *Discovery of Mystery*	The student will discover various mysteries through research and sharing of information with peers.
Category of Activity *Introduction of mysteries with a focus on language art and integration of technology.*	The student will be introduced to what makes a mystery by researching various topics pre-selected by the teacher.
Annotation *The students will be given the opportunity to learn to research various topics and what a mystery is and various topics concerning mysteries.*	The student will use inspiration prepared by the teacher to research a topic. The student will make a news report with a video recorder to report what he/she found from his/her research. The student will use a news article template to write an article about his/her finding on the mystery. The student will discuss with peers about other mysteries on the article he/she read from his/her peers and the video he/she observed from his/her peers news report that was produced on video.
QCC Standards *Oral communication and written communication.*	The student will use his/her oral communication skill when making the news report on video. The student will use his/her written communication skills when making the news article to express his/her ideas and information on a specific mystery.
***Procedure**	
Text of Procedure- Directions The students will be given detailed direction on the mystery project. The students will be told that they will use inspiration page that I the teacher will provide to research a specific mystery. The students will be shown by the teacher how to open the link on inspiration. The student will be put into a group of 3 or 4 to work on the project. The student(s) will be assigned a specific mystery to research. As a class the student will discuss what makes a mystery. Elements that make a mystery: a. Not enough information. b. No tangible proof. c. The element of knowing. d. Many different sides to story…which to believe. e. That it is factious. After discussion the student will have the opportunity to research his/her specific mystery and the location in which the mystery has taken place. The students will take hand written notes on his/her findings. As a group they will discuss what issues or facts that make the specific topic a mystery. The	

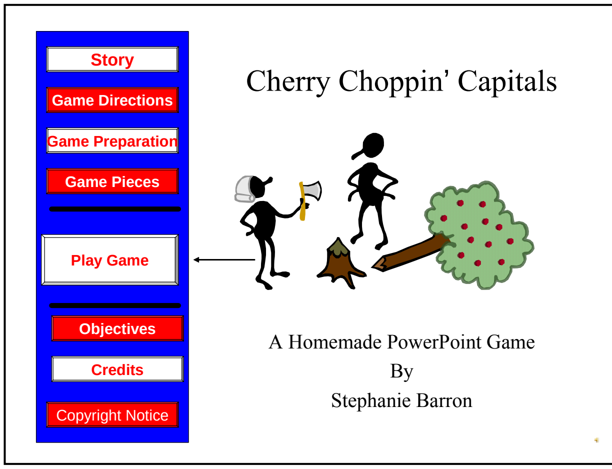
students will also gather information that they find interesting. (For example: how many sightings). The student then with group will out line a topic to report on the news. Then each student will have an opportunity to film their findings and report. The class as a group will have the opportunity to watch each group's video. The class will have an opportunity to ask each group questions about his/her findings. After the completion of the video viewing the class will be given instructions on how to open the newspaper template on his/her PC. The child will open Microsoft word and then go to Insert text box where he/she will type two boxes that are next to one another. Also, they will include a Title to his/her newspaper. Each child will also be the given the opportunity to include clipart. The students will then make copies 7 copies of their article. Then the teacher will put together a book of newspaper articles for each group. Then the groups will have the opportunity to look all the other mysteries and discuss why they are mysterious. As a class we will discuss each mystery and why it is a mystery to re-cap what was just learned.	
Attachment #1 –	Worksheet on what makes a mystery. Title: The Makings of a Mystery
Attachment #2 –	
Web Site #1	All Inspiration links. There are several web pages linked onto Inspiration that is appropriate to grade level and useful to research.
Web Site #2 –	All Inspiration links. There are several web pages linked onto Inspiration that is appropriate to grade level and useful to research.
***Assessment**	*The assessment will be seen in the video, newspaper articles, and class discussion. Teacher should be able to observe if the child grasp the concept of mystery and should be able to assess students' oral and written communication skills by articles and video recordings.*

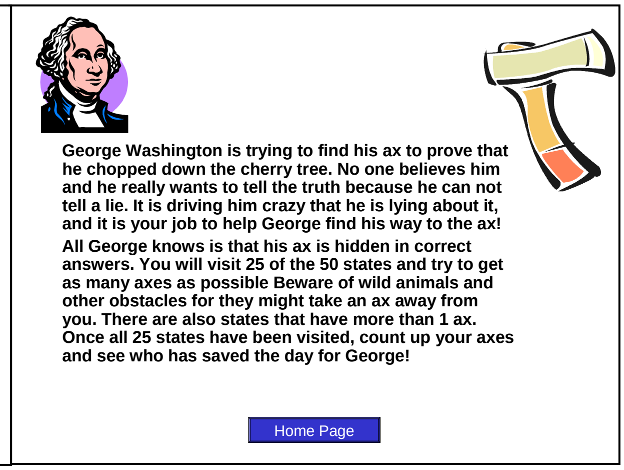
Inspiration Instructional Material: The Makings of a Mystery

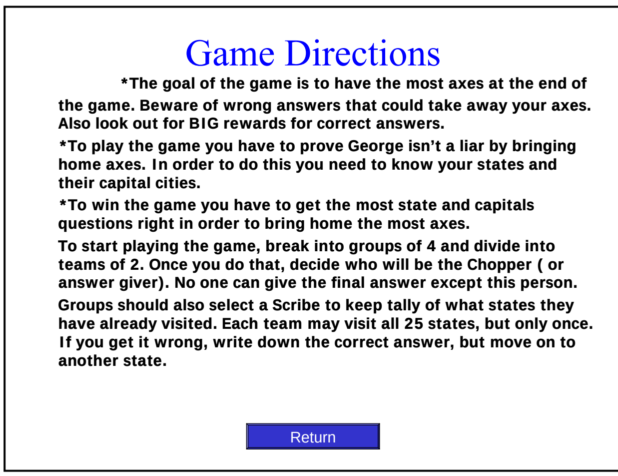


Appendix E

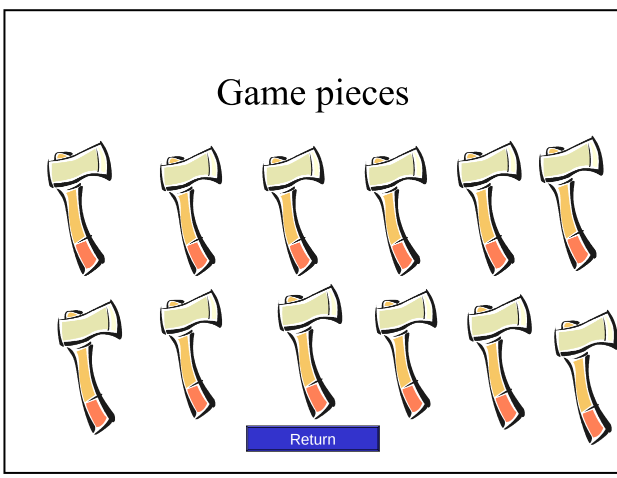
Sample PowerPoint Game


Story
Game Directions
Game Preparation
Game Pieces
Play Game
Objectives
Credits
Copyright Notice
Cherry Choppin' Capitals
A Homemade PowerPoint Game
By
Stephanie Barron


George Washington is trying to find his ax to prove that he chopped down the cherry tree. No one believes him and he really wants to tell the truth because he can not tell a lie. It is driving him crazy that he is lying about it, and it is your job to help George find his way to the ax!
All George knows is that his ax is hidden in correct answers. You will visit 25 of the 50 states and try to get as many axes as possible Beware of wild animals and other obstacles for they might take an ax away from you. There are also states that have more than 1 ax. Once all 25 states have been visited, count up your axes and see who has saved the day for George!
Home Page


Game Directions
*The goal of the game is to have the most axes at the end of the game. Beware of wrong answers that could take away your axes. Also look out for BIG rewards for correct answers.
*To play the game you have to prove George isn't a liar by bringing home axes. In order to do this you need to know your states and their capital cities.
*To win the game you have to get the most state and capitals questions right in order to bring home the most axes.
To start playing the game, break into groups of 4 and divide into teams of 2. Once you do that, decide who will be the Chopper (or answer giver). No one can give the final answer except this person.
Groups should also select a Scribe to keep tally of what states they have already visited. Each team may visit all 25 states, but only once. If you get it wrong, write down the correct answer, but move on to another state.
Return


Time to play Cherry Choppin' Capitals
Arkansas
Iowa
MONTANA
Georgia
ALASKA
DELAWARE
ILLINOIS
South Carolina
COLORADO
CONNECTICUT
New Hampshire
MARYLAND
Vermont
Wyoming
Washington
Massachusetts
Kansas
MISSISSIPPI
INDIANA
TEXAS
NEBRASKA
KENTUCKY
South Dakota
Home Page
Game Directions


Game pieces
Return


What is the capital of Maryland?
Baltimore
Annapolis
Chestertown
Leesburg

Appendix F

Sample WebQuest

ROCK and ROLL!

A WebQuest for 3rd Grade Science

Introduction | Learners | Task | Process | Evaluation | Conclusion | Credits

This newspaper article was taken directly out of the Atlanta Journal Constitution: HELP! A miner in Dahlonega Georgia has just found a new type of rock. Some believe this rock could be millions of years old or just newly found by humans. Others believe it is just a mutation of a previously discovered Metamorphic rock. Some have stated that it does not fall under any category of rocks. Researchers, Scientist, and Geologist are being requested to solve this complicated mystery of "what is this rock, where does it fit into the scientific categories", and if it does not what type of category will the scientific community place the mystery rock into. If scientific proof is accurately given in solving what type of rock this mystery rock is an award will be given. If you crack the case this mystery rock will be named by you. Please help, this rock could be very important to human survival in the future. It could be the new means of fuel or maybe just an interesting rock for rock collectors. The possibilities are endless. If interested in investigating this rock and potentially making one of the biggest discoveries of the 21st century email us at mysteryrock@labresarch.org we will send you the mystery rock for extensive examination.

Learners

This lesson is geared toward third grade science and involves deductive and reasoning skill. The type of science this will involve is earth science and geology. The student will need to have some extent of understanding of the primary groups of rocks (igneous, metamorphic and sedimentary) and know the characteristics of each rock types are a direct result of how they are formed. This lesson can be modified to fit several other grade levels depending on the amount of information you provide and type of experiments you allow your students to perform.

Task

Here is the objective:

You will be given the mystery rock. You must decide which category (***igneous, metamorphic and sedimentary)*** the mystery rock fits in. You will identify the rock's category by investigating if the mystery rock already exists and what particular type of rock it really is. Knowing how each group of rocks is formed and what makes each group different from one another will help you in your important investigation. You will examine the mystery rock and determine it's characteristics through observation and experimentation. After observation and experimentation you will have a clear understanding about the mystery rock's characteristics which will help you place the mystery rock into the correct category. Once you conclude which group the mystery rock fits into: you will search to see what type or rock the mystery rock is.
Groups of three are needed: -Geologist -Researcher -Scientist
Each person will need to provide information why the mystery rock fits in the correct category from their own perspective. Each student will make a slide explaining his/her reasoning of why it fits and why it does not fit into other categories. Each person will use deductive reasoning skill and find the name of the rock.

Process

Each group will be given a mystery rock.

Perform experiments on mystery rock- such as texture test, chalk test, taste test, and dullness, and breakability of rock.

Determine characteristic of mystery rock.

Each person, (Geologist, Researcher, and Scientist) search the resource section and determine which category the mystery rock fits into base upon his/her findings.

Search resources to see if you can find the name of your rock.

Once you have cracked the case make a power point slide listing why your solved mystery rock fits into its particular category.

Make a power point slide listing why your mystery rock does not fit in other categories.

Be creative with your slides.

Group presentation will include each person speaking on his/her findings and why it fits into its particular category and not others.

While presenting class may ask presenters questions about their mystery rock.

Presenters will also display mystery rock while presenting their power point slide(s).

Resources

Ask Geo Man: ***A detailed description of the three different types of rocks. Includes links to related information.***
http://jersey.uoregon.edu/~mstrick/AskGeoMan/geoQuerry13.html
***Become a Rock Expert**: An interactive site where one can study about rocks and take a quiz.*
http://www.fi.edu/fellows/fellow1/oct98/expert/index.html
***A Show of rocks**: A detailed descriptions of various rocks. Includes links to related information.*

http://volcano.und.nodak.edu/vwdocs/vwlessons/lessons/Slideshow/Slideindex.html
Igneous rock: A detailed description of Igneous rocks and pictures.
http://volcano.und.nodak.edu/vwdocs/vwlessons/lessons/Igrocks/Igrocks1.html
Metamorphic: A detailed description of Metamorphic rocks and pictures.
http://volcano.und.nodak.edu/vwdocs/vwlessons/lessons/Metrocks/Metrocks1.html
Sedimentary: A detailed description of Sedimentary rocks and pictures.
http://volcano.und.nodak.edu/vwdocs/vwlessons/lessons/Sedrocks/Sedrocks1.html

Evaluation

You will be evaluated individually based on your personal Power Point slide(s) that reflects your particular job and perspective. You will also be evaluated on your participation in the "Rock Mystery" investigation.

	Beginning 1	**Developing 2**	**Accomplished 3**	**Exemplary 4**	**Score**
The "mystery rock" placed in correct category. Bonus: naming the mystery rock correctly + correct category= +1	Placed rock in incorrect category with no explanation.	Placed rock in incorrect category with an understandable explanation.	Placed rock in correct category with a vague explanation of why it fits.	Placed rock in correct category with a well thought out explanation. Also, figured out the real name of the rock.	
Logical explanation of why the "mystery rock" fits in the particular	No/ incorrect explanation provided.	The explanation incorrect but had some thoughtful reasoning provided.	The explanation correct but did not provide all the reasoning of why the rock fits.	The explanation correct and provided all the reasoning of why the	

Logical explanation of why the “mystery rock” does not fit into particular categories.	No/ incorrect explanation provided.	The explanation incorrect but had some thoughtful reasoning provided.	The explanation correct but did not provide all the reasoning of why the rock did not fit.	The explanation correct and provided all the reasoning of why the rock did not fit.	
Power Point presentation clear and creative.	Incomplete presentation.	Most of the presentation provided.	Complete presentation.	Complete presentation with added detail.	
Student(s) Participation in effort in cracking the mystery and developing the Power Point.	Student did not do his/her Power Point slide. Student did not do his/her research.	Student did part of his/her Power Point slide. Student did part of his/her research.	Student did his/her Power Point slide. Student did his/her research.	Student did his/her Power Point slide and provide extra information. Student did outside research.	

Conclusion

This activity allows you to investigate and explore different types of rocks and place them into the correct category.
What are the differences between Metamorphic, Igneous, and Sedimentary?
What characteristic do these categories have in common, if any?
Did your mystery rock fit into any other category’s characteristic?
What are all the characteristics for a Metamorphic rock?
What are all the characteristics for an Igneous rock?
What are all the characteristics for a Sedimentary rock?

Appendix G

Web-Based Case-Based Doing Tool (CBDT) Manual

The Web-based Case-Based Doing Tool (CBDT) Manual

http://projects.coe.uga.edu/mhkoh/index.asp

What is case-based doing (CBD)?

When your friend asks you how to do a certain assignment in the course you already took last semester, what do you *tell* to your friend? You may start with a story about your experience—how you did it and what lesson you learned from that *experience* rather than with a textbook-like list of the principles for a successful assignment.

You may be an expert in one or more fields in your life such as cooking, playing baseball, or troubleshooting a computer. If you are an expert in a particular field, that means you have rich *experience* and, thereby, you have many *relevant stories* (e.g., stories about when it was difficult) to tell others.

We keep our memories and knowledge as *stories* in our minds. We use the stories in solving relevant new problems. Here, we call it **case-based doing (CBD)**.

Why is CBD useful?

Let’s get to the point in this course.
What experience do you have with teaching? How about teaching with technology?

You are a very promising preservice teacher, aren’t you?☺ You are still a novice in teaching and teaching with technology, though. That means, again, you don’t have rich *experience* and relevant *stories* to tell others such as stories about teaching in this way in this situation or using technology in that way in that situation.

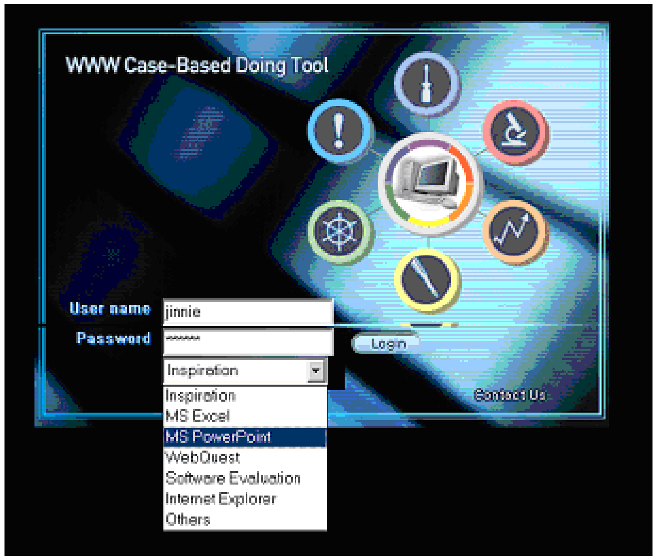
How can we have experience and stories in a college course without having real teaching experience in schools? Don’t worry about that! That’s why we are providing you this way of learning to teach with technology in this course.

Here is the first strategy.
If you don’t have your own experience, just borrow others’—experts’ stories and their knowledge to make your own. Again, here we will use the idea of **case-based doing (CBD)**!

Let’s take a look at the details.

How can I do CBD with CBDT?

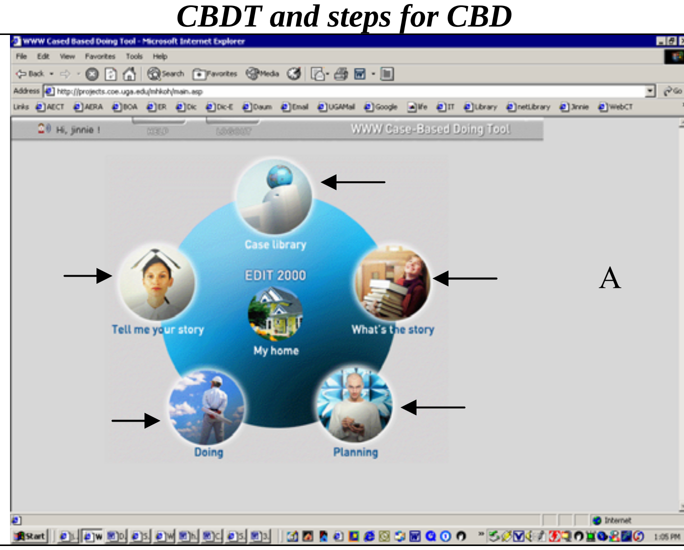
Login Page
(http://projects.coe.uga.edu/mhkoh/index.asp)



User name: *Your UGA email id* Password: *Last four digits of your SS#* Choose a software program (e.g., Inspiration) Click "Login"

Before explaining CBD, let's take a look at the Web-based case-based doing tool (CBDT) because you will use CBDT for completing your CBD at every step.

<table>
<tr><th>Steps for CBD</th><th>CBDT and steps for CBD</th><th></th></tr>
<tr><td>A. Select your project
B. Find the relevant case
C. Analyze the case
D. Plan your project
E. Act upon the plan
F. Tell your story</td><td>



A</td><td></td></tr>
</table>

A. Select your project

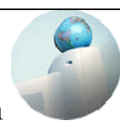
You will complete several projects in this course, such as developing an instructional material by using Inspiration and evaluating software programs.

When the instructor introduces the project (e.g., project scope, due date), you need to decide and identify the details of your own project including key components: Who (target students' grade and characteristics such as prior knowledge and technology skills), where (classroom, lab, field), what (content area, learning goal(QCC), etc.), and how (pedagogy).

B. Find the relevant case of an expert teacher

After deciding the rough scope of your project, find relevant expert's cases in the case library. You can get the cases in the form of recorded videos, reports, or live teachers' story telling. Here, we provide those cases through our Web-based CBDT.

Although there are many experts' cases for various situations, in our CBDT, we provide you a case relevant to each project. If you want to see various cases more, use more than 1000 cases from the following sites: InTime cases (http://www.intime.uni.edu/video.html) and KITE cases (http://kite.missouri.edu/jkite/browse.htm).

CBDT Go to CBDT	If you click on  **Case Library**, you can see a list of WWW cases in the pop-up window. Choose the case related to each course project.

C. Analyze the case—what story did the expert tell you?

After watching the case of an expert, you deeply analyze what the expert did and why and how. Write your case analysis in terms of the template on CBDT. If necessary, you can repeatedly view the case.

Template Know what you should write	Here is the template that guides your case analysis. Refer to the concept and example writing of each template. **Story summary.** Summarize what the expert teacher did. Your summary should include a clear description of the situation including the key components: Who (teacher name, students, who else),where (classroom or lab), what (content area, learning goal), and how (pedagogy). **Technology Integration.** Tell why the teacher used technology and how. Describe what strategies the teacher used for student learning. **Potential of the S/W program.** So, tell what the educational value and characteristics of the S/W program (e.g., Inspiration, WebQuest) are.

Critique. Tell strong and weak points, possible obstacles, the extent of its usefulness for your project, etc.

Example

Refer to an example

Story summary	This teacher, Ms. Howard, was teaching her ESL class how to do research. Research can be a daunting process for any student, but especially for a student who does not speak English as their first language. Ms. Howard made this project manageable as well as interesting for her students (making the research about a toy, specifically a kite.) Throughout this process, she was using many different resources to teach her students the basics of doing research. First, she compiled sources for her students to use in the research process. She had the students do individual research, and then as a class come together and cooperatively share information. The students used Inspiration to graphically organize their research. Later, the students created a booklet all about kites based on the research they found. Ms. Howard guided her students through the entire process. She would always ask her students questions and encourage them to think for themselves.
Technology integration	Ms. Howard used technology to facilitate her class in learning about the process of research. The internet is a rich resource when it comes to research. By teaching her students to use basic technology equipment, such as a computer, she is preparing them for success later on. Technology is such an integral part of our society. Although she was making her students create a booklet about kites, Ms. Howard was also teaching basic computer competency in word processing. The purpose of technology in this project was to aid her students in compiling and organizing thoughts. Technology proved to be an effective and interactive way of teaching about the research process.
Potential of the S/W program	Inspiration is a very helpful tool that can assist a teacher in presenting a lesson or creating a webbing or mapping tool for her students to use. It is a facilitator between students and the teacher as a way. It is not the objective of learning but a tool to facilitate learning.
Critique	When creating my lesson with Inspiration, I need to be mindful of how I can incorporate students into the process and make learning meaningful for them. Also, I need to create an effective way of assessing their knowledge of what was learned when using a program like Inspiration. Ms. Howard did not have a very concrete idea of how she would assess her students' work. When creating my own lesson, I want to have clear objectives and make sure the students are aware of what I expect from them.

CBDT

Go to CBDT

If you click on  **What's the story**, you can see a template for writing. Type in what you think.

D. Plan your project

Now, plan your own project, guided by the expert's case and advice.
What will you develop and why?
As a result, you will have your lesson plan based on your initial planning.

Template Know what you should write	Here is the template that guides your case analysis. **Your scenario.** Describe and refine your scenario including the key components: Who (target students' grade and characteristics such as prior knowledge and technology skills), where (classroom, lab, field), what (content area, learning goal (QCC), etc.), and how (pedagogy). **Ideas form the case**. Tell what situation is different and common between the case and your project. What you will apply or adjust from the teacher's case for your project. **Technology integration.** Tell why you will use the s/w program(s) and how. Describe what obstacles would happen during implementation.

Example

Refer to an example

Your scenario	By reviewing the second grade mathematics QCC objectives, I have decided to change topics to learning about shapes and spatial relationships. I would be covering several QCC objectives. The first objective being, "Identifies and draws circles, squares, triangles, ovals, and rectangles. Identifies spheres, cubes, cylinders, and cones of various sizes, in various orientations and positions." Another objective covered would be, "Identifies the shapes that can be put together to make a given shape." By making a Web and connecting with arrows, I could have a section for two-dimensional shapes and then separate into no-sides, three-sides, etc. By assigning the various shapes to these group headings, I would also be incorporating, "Organizing elements of sets according to give characteristics," This lesson will be held in the classroom that consists of a computer and a projector. I will mainly use the computer and students share it when they need to use.
Ideas from the case	This lesson will provide the students with an understanding of shapes and how they are related to one another. I expect students to learn the different characteristics of shapes. Many shape share similar characteristics and can be grouped together. For example, in this lesson, I will have the students help me organize shapes based on number of sides. Several shapes will go into one category. By using Kidspiration, the students can see the relationships among shapes. By then taking our two-dimensional shapes, we can build on that knowledge to create the three-dimensional figures.
Technology integration	I will be using technology in this lesson because it will facilitate the process of making the advance organizer. By using Kidspiration to make my advance organizer, the students can see the relationships between the shapes. I can also integrate a technology QCC, by using Kidspiration for this lesson. With this guided practice, the students will also have an opportunity to feel comfortable with this

	webbing/organizational software. My math lesson about shapes is simply a review and only some new information. My concern as I present this lesson is that most of it may be too simplistic. The review portion should be concepts the students understand easily, but I feel it is necessary to review these original shapes to help build the three-dimensional figures. Also, by using Kidspiration to present a lesson on spatial relationships, it may be hard for the students to visualize how the two-dimensional shapes are used to create the three-dimensional figures. To help solve this problem of visualizing a three-dimensional object, I could have models available of various three-dimensional figures (ex: pyramids, which might be especially difficult to visualize).

CBDT Go to CBDT	If you click on  **Planning**, you can see a template for writing. Type in what you think.

E. Act upon the plan

Act upon your plan. You may develop an instructional material using certain software programs or may practice teaching based on your plan. However, you may also encounter some unexpected difficulties. For *reflection in action*, use CBDT to journalize what you are thinking.

Template Know what you should write	Here is the template that guides your case analysis. Refer to the concept of each template. **Learning from peers.** What feedback did you share each other? What did you learn from feedback? So, what did you add or delete for your original plan. **Journaling.** Jot down what you are thinking and finding while developing your technology-enhanced lesson plans and materials (e.g., frustrating, surprising, interesting)

Example

Refer to an example

Learning from peers	My peers said that my lesson plan was too long for a lesson, so I reorganized students' activities so that they can enjoy their learning within enough time.
Journaling	Developing new material to present to students is a very tedious process. Considering all the QCC objectives one can incorporate as well as issues that may arise during the lesson encourage me, as the teacher, to seriously consider all facets of the lesson. In addition, sometimes it is hard to remember that I do not want to overwhelm my students with too much information. When creating this lesson concerning shapes, I was enthusiastic to include an abundant amount of information I knew concerning shapes, including the terms isosceles, equilateral, prisms, etc. I had to remind myself I was teaching this lesson to second grade students. I need to keep the lesson at a level they can understand.

CBDT Go to CBDT	If you click on  **Doing**, you can see a template for writing. Type in what you think.

F. Tell your story

Eventually, you will have your own story that comes from your experience. So, tell me your story. What did you do and why? What did you learn from that experience?

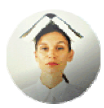
Template	Here is the template that guides your case analysis. Refer to the concept of each template. **<u>Resources.</u>** What did you utilize for developing your lesson and material? (e.g., Teachers' cases, QCC Websites, Web resources, books, the instructor, peers, etc.) What was useful or not and why? **<u>Lesson(s) learned :</u>** What difficulties did you encounter and how did you resolve them during this project? If you have the same project later, what will you make better? **<u>Help Susan!.</u>** Write to Susan, a beginning teacher, who is willing to use this program for her lesson but does not have no idea. Molly [the instructor] will give you her letter in class. Use your reflection described above.

Example

Refer to an example

Resources	I used a lot of Internet resources and also went down to the curriculum library, that's the first time I'd been there. I used textbooks and normal books that were really helpful in creating the questions and the research options. I also asked my roommate about my project and could have some ideas.
Lesson(s) learned	The most difficult part would be finding resources or piecing everything together and making it make sense. I would throw around a few ideas about ways to assess them. It took me awhile to think about and process. At that time, I asked the instructor about the different ways to access. She gave me great ideas. I thought about what she said and came up with that tribal counsel idea where the students would have tell their teacher or the chief, what they had learned and just grade them on basic overall group work and the research guide and the completion of that. Therefore, I was able to have some ideas.
Help Susan!	Dear Susan, I think Inspiration is a great tool to help a teacher present a lesson or create a webbing or mapping tool for her students to use. I can't really say but it just helps everything become clear and it is just a good tool to facilitate the learning. I don't think it is the learning itself but I think it is to facilitate learning. I used Inspiration to teach mathematics for second graders. The

	content was about shapes and spatial relationships. I think the topic is important to use Inspiration. When I tried to use Inspiration to teach time of math, I found it would not be effective because time seems difficult to be taught using webs and have somewhat vague process with my original idea. I think the topics such as shapes and spatial relationships are appropriate because shapes are a more visual concept than time. Through my experience, I think Inspiration is useful because it includes many graphics for shapes and also to easily and clearly build a concept map that would show the relationship between shapes and figures. By having access to this technology, the students can focus on discovering the relationships and the arrows provide a clear visual. In addition, this concept map could be printed out and the students could use this for studying purposes. If I had simply drawn all this on the board, it would have been difficult for the students to look back and remember if they did not have a copy of the information we had covered. Using Inspiration facilitated the process of having an that Inspiration is very helpful for students to have visual representations of what we are learning. Having that picture in their minds helps them remember the material more easily. That's all I can answer for now. If you have any question, feel free to ask me. Sincerely, Amy

CBDT Go to CBDT	If you click on  **Tell me your story**, you can see a template for writing. Type in what you think.

Appendix H

Sample CBD Report: Captured

My Home-Inspiration (Alex Conner)

1.What's the Story?
1.Story Summary: Summarize the case including the key components: Who (teacher name, students, who else), where (classroom or lab), what (content area, learning goals), and how (pedagogy).
Theresa Farrell teaches Language Arts to 5th and 6th grade special education students at Red Oak Elementary School. The class was so small that they could work on the project as a class on one computer. The project was to learn about tornados and use pre-reading skills to create a web using Inspiration. After listening to the story Night of Twisters on tape the students compared their web to the story and then together wrote a paragraph about what they learned about tornados using word processing software.
2.Technology integration: Why did the teacher use technology and how? What strategies did the teacher use for student learning?
The teacher used technology for enrichment of the activity. The students respond well to the use of technology in her class, especially to the projector. She kept them confined to one computer and working as a group because, being special ed, they tend to lost in a large lab. They also work better on a computer in groups so that they can help and support each other. She used two technological tools: Inspiration to create a web and a word processing program to collectively write a paragraph. She was very careful to make sure that the students felt encouraged by the use of technology rather than intimidated.
3.Potential of the S/W program: So, what are the educational value and characteristics of the S/W program? (e.g., Inspiration, WebQuest)
Inspiration is a web-making tool. It aides the students in their pre-reading skills. It also gives them a chance to document these skills and compare them to what is actually in the story. Inspiration is also very simple to learn and modify the web into an outline. This gives the students another way to organize their thoughts. The word processing tool is just a way to get the students accustomed to typing rather than simply writing. This is a skill that they will need more and more as they continue their education and it is much easier to start when they are young.
4.Critique: Strong and weak points, possible obstacles, the extent of its usefulness for your project, etc.
The strength of this exercise is the teacher's ability to adapt it to the students' needs. It had the potential to become very difficult and discouraging for the students, but since they were able to work together and explore the technology with a little more guidance from their teacher and classmates, they seemed to really enjoy it and learn a lot about tornado safety from it. However, since the class was working as a group, the only possible weakness would be in the assessment. The teacher really only has a sentence or two of concrete information to grade them on. But, in special ed, the focus is more on the students' learning rather than the grade. So in that context it was very useful. The students were not only more informed about tornado safety but also about some of the technological tools that are available to them.
5.Other thoughts

2.Planning

1.Introduction to your scenario : Describe and refine your scenario including the key components: Who (target students' grade and characteristics such as prior knowledge and technology skills), where (classroom, lab, field), what (content area, learning goal (QCC), etc.), and how (pedagogy).

My target students are fifth grade resource students. Although they are lower than their grade level, I think these students would have a pretty good handle on using computers. I would like to do this project in groups with each group being in charge of one part of the web and then combining them in the end to create one big map of the parts in a story. My intention is to read Superfudge by Judy Blume together. After briefly discussing the story I would split the students into small groups or pairs depending on the size of the class. Then each group would be assigned an aspect of the story such as characters, setting, problem, solution, and main events. The students will then use Inspiration to create their webs to organize the information. After the webs are completed we will all come together as a class and combine the webs into one much larger one that contains every aspect of the story. This web will be used to write book reports individually afterwards. The QCC reading objectives that this would address are reading comprehension skills as well as being able to recognize specific elements of a story. It would also address the objective of communicating written ideas by using the writing process which includes prewriting, drafting, revising, editing, and publishing. The technology related OCC objective that I would target is to use brainstorming or webbing software to plan, organize, and pre-write.

2.Ideas from the case : What situation is different and common between the case and your project? What will you apply or adjust from the teacher's case for your project?

My project will be different from the Night of Twisters case mainly because of the setting. My students will work on their own with some assistance from me when needed. They will have each other as support as well since they will be in small groups. However, in the end we will come back together to create the "superweb" by combining each group's smaller web. This would be done by me using a projector which is similar to Theresa's method of teaching. Another similarity is that the basis of the webs is a story that the class reads.

3.Technology integration : Why will you use the s/w program(s) and how? What obstacles would happen during implementation?

I think Inspiration is a perfect way to show the students some more creative ways to prewrite. That is a very important part of writing, especially for developing writers who need to learn the techniques of organized writing. Using webs is much more organized and effective than maybe brainstorming or trying to create an outline. And of course, the kids really love using this program so it gives them more motivation to really do a good job on this project. Hopefully after this they will really understand how much easier it is to write a report after doing a detailed prewriting web.

4.Other thoughts

3.Doing

1.Learning from peers : What feedback did you share each other? What did you learn from feedback? So, what did you add or delete for your original plan?

After looking over my project, Sarah had a few suggestions for me. She said that my lesson plans were very detailed, but kind of hard to follow in the paragraph format. She suggested numbering them like we talked about in class and I thought it was a good idea so simplified them by making concise steps for teachers to easily follow. Although my web was not completed, Sarah and I also discussed how the arrangement would probably be much neater if it was in the top-down format, rather than the cluster that I had already started to form. After changing those two aspects of my project I felt like it was much more organized for both the teachers when giving directions and the students when using their web as prewriting for a book report.

2.Journaling : Jot down what you are thinking and finding while developing your technology-enhanced lesson plans and materials (e.g., frustrating, surprising, interesting)

I expected the lesson plan to be the easiest part, which is why I decided to do it first. However, once I started it, I realized that there were many parts to my project that I hadn't been considering as I drafted the lesson plan in my head. Writing a lesson plan involves incorporating every last detail to provide the teacher with a lesson plan that they could actually take into their classroom and implement with their students.

3.Other thoughts.

4.Tell Me Your Story

1.Resources : What did you utilize for developing your lesson and material? (e.g., Teachers' cases, QCC Websites, Web resources, books, the instructor, peers, etc.) What was useful or not and why?

I used a few different resources to complete each part of this project. For the initial idea, I actually adapted something I saw students doing in a class that I volunteered in last year. However, their project did not integrate technology, so that was the hard part of creating the lesson. I also used the GLC website for two reasons. I needed it to figure out what QCC objectives I was hoping to meet through this project and I looked at some of the lesson plans found on the website to create the assessment part of the lesson plan. I wasn't entirely sure how to assess something like this but using a rubric was an obvious idea that I got from the website. Finally, as I was finishing up my project, I asked my mom who is a teacher to look over it and make sure the lesson plan looked easy to follow. She also assisted me in organizing the web, even with the top-down format there was some rearranging to do.

2.Lesson(s) learned : What difficulties did you encounter and how did you resolve them during this project? If you have the same project later, what will you make better?

The biggest problem I had with the web was trying to make it all fit onto one page so that the students would still be able to read it. There were so many parts to the web and then quite a bit of information to branch from each main idea that it got cluttered very quickly. I think the best way to remedy this problem would have been to use the tool that creates notes for each of the elements of the story rather than creating a new bubble for everything. This would help to make it much more organized and easy to read. Also, I think I could always improve my lesson plans by adding more details. It's very hard to write them when you already have the idea of what you want to do in your head because it is easy to assume the teachers know what you are thinking and then leave out some of the more simple but crucial steps.

3.Help Susan! : Write to Susan, a beginning teacher, who is willing to use this program for her lesson but does not have no idea. The instructor will give you her letter in class. Use your reflection described above.

Dear Ms. Jones, First of all, I think it is wonderful that you have been trying to integrate technology into your class, even with such limitations. Since my Superweb project would be done in groups, I think it would be easy for you to adapt this to your classroom. Rather

than making a class trip to the computer lab, creating the webs could be part of a center. First each group would make some plans for their web, on paper. As each group finishes their plan, they could take turns creating their webs using the computer. This way their time on the computer would be used strictly for production, rather than trying to generate ideas as well. Then after each group was done you could create the Superweb and print out copies for each child so, while they weren't able to witness you creating it, they could still view and discuss the final product. I hope this helps you out and you are able to continue using technology in your classroom. Sincerely, Alex Conner.
4.Other thoughts.

Appendix I

Sample Letter to Susan

Ms. Jones

J. C. Cobb School

November 19, 2004

Dear Inspiration Lesson Designer,

I just came across your WebQuest on the Internet and was interested in using it with my students. I teach the same grade level and subject area and have been looking for a better way to explain this topic my students. I really think it will make them more interested in the subject.

I've just started integrating technology into my classroom and I'm starting to get more comfortable with it. I'm always looking for new ways to use it to help present my content area. The only trouble I am still having is finding ways to adapt lessons that I find on the Internet to the limitations I have in my classroom.

I would really like to use your WebQuest with my students but it seems like it will take more time than I had planned for this particular topic. Is there any way that your WebQuest can be adapted to use less instructional time?

Thanks so much for your help!

Sincerely,
Ms. Susan Jones

Appendix J

Research Questions and Data Sources

Research questions	Major data sources
How does their understanding about the educational roles of technology change?	• Interview I • Interview II • Interview III • Instructor interview • CBD reports • Artifacts • Microteaching & e-portfolio reflection • Field notes
How does their understanding about the concepts for teaching with technology develop?	• Interview I • Interview II • Interview III • Instructor interview • CBD reports • Artifacts • Microteaching & e-portfolio reflection • Microteaching video tapes • Field notes
What strategies do preservice educators use and develop for the Web-enhanced CBR activity?	• Interview I • Interview II • Interview III • CBD reports • Microteaching & e-portfolio reflection • Field notes
How do preservice educators use the structure and components of the Web-enhanced CBR activity?	• Interview II • Interview III • Instructor interview • CBD reports • Artifacts • Microteaching & e-portfolio reflection • Microteaching video tapes • Field notes • Memos from conversations with the instructor

Appendix K

Interview Protocols

Preliminary Interview Protocol

1. Tell me about yourself (Age, major, and learning style)
2. Tell me when students learn best
3. Whom do you think of as an exemplary teacher?
4. Tell me about your experiences in teaching and lesson planning
5. What level of technology skills (i.e., computer and the Internet) do you think you have? (Pick a number between 1 and 10)
6. Tell me about your experience of using technology throughout your K-12 and college education
7. Why are you taking this course? What was your expectation for learning before you came to this course?
8. What have you learned about technology integration in this course so far?

* Initial perception and understanding of technology integration

9. What is your definition of technology integration?
10. Tell me about your opinion of how computers help teaching and learning
11. How do you think that an exemplary teacher uses technology in his/her classroom? Describe the classroom in which technology is used
12. What skills or knowledge does a teacher need for technology integration?
13. What do you think are the obstacles to using technology in teaching?

Second Interview Protocol

1. Give me a brief description of your experience with the course projects.
2. Have you experienced the projects (Inspiration, WebQuest, PowerPoint game, or microteaching) and the software programs before?
3. What did you expect the course project would be like in the beginning?
4. Why did you decide upon the project as your scenario?
5. Where did you get the ideas of activity processes in your lesson plan?
6. When you developed your Inspiration material and PowerPoint Game, what was in your mind?
7. We watched a video case. What did you perceive from it?
8. How did you perceive peer feedback?
9. How did you use the instructor in the project?
10. How did the guiding questions in CBDT help your lesson plan and your project?
11. How did you utilize resources (e.g. QCC websites, samples, textbooks, friend) ?
12. Through these projects, how does your view of teaching with technology differ from your previous view?
13. How does Technology (e.g., Inspiration) contribute to teaching your content (e.g., English) in K-12 (e.g., high school)?
14. What have you learned new about teaching with technology so far?

Third Interview Protocol

1. Give me a brief description of your experience with the course projects. How did you complete your WebQuest?
2. Why did you develop this scenario?
3. Tell me your story about the experience with the microteaching activity
    a. Could you briefly explain how you prepared for microteaching?
    b. What did you perceive during microteaching?
    c. What was the lesson you learned from this project?
4. The following question is about your entire experience in this course. We have several different realistic projects similar to real teachers' jobs including Inspiration, WebQuest, Web-Resources, and PowerPoint game. In every task, how did you complete each project? Did you have your own typical procedure to complete the project?
5. How was this course to you? What is your overall evaluation?
6. What did you learn through this course? What did you change through this course?
7. Do you have a plan to use anything you learned in this course in your future?
8. How much do you perceive your learning for technology skills in this course? What technology did you learn?
    a. After taking the course, what level do you think of your computer and Internet skills? Pick a number between 1 and 10.
9. How does your view of technology and education differ from your previous view?

* Final understanding of technology integration

10. What is your own definition of teaching with technology or technology integration?

11. What is the most important factor in using technology for your teaching in your classrooms without problems?

12. Tell me about your opinion of how computers help student learning and teaching

13. How do you think that an exemplary teacher uses technology in his/her classroom? Describe the classroom in which technology is used

14. What skills or knowledge should a teacher have for technology integration? What do you think some of the obstacles are for using technology in teaching?

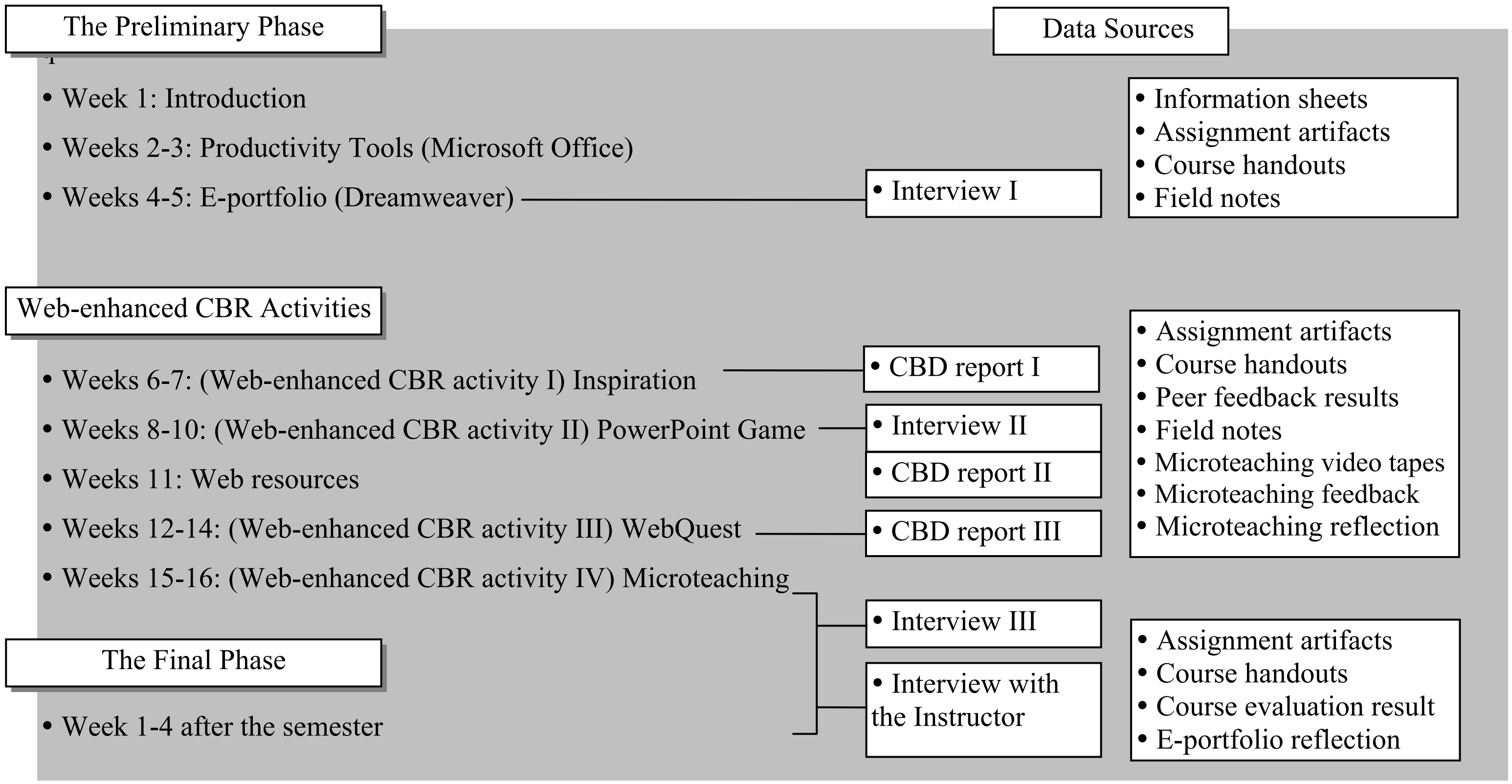
Instructor Interview Protocol

1. What did you perceive about this course compared to last semester's EDIT2020 course?
2. Overall, how did you perceive the structure and implementation of the CBD units this semester compared to last semester?
3. What do you think of students' writing in CBDT?
4. How did you perceive that students react to CBDT for their projects?
5. What risks and challenges did you have during the semester? Could you tell me some examples?
6. What do you think of the role of the teachers' video cases for students' projects?
7. What should we improve or refine for the next semester?
8. In your experience of this course, what assignments did students find most difficult to complete and why?
9. In your experience of this course, what assignments did students find most useful or favorable to complete and why?
10. How did you perceive students did microteaching?
11. Was there any difference from other EDIT2000 courses when you helped students, and graded their work?
12. What kinds of questions and feedback were shared this semester? Could you tell me an example?
13. (We had scenario work, planning, development for lesson plans and instructional materials, and microteaching, and reflection) In this type of the course, what facilitation skill of the instructor do you think is needed to implement it successfully?

14. What do you think of the quality of students' work?
15. How did you perceive students' understanding of technology integration change over a semester?
16. Do you think those activities influence other course activities?
17. How and to what extent do you think that student will use knowledge/skills learned from this class in their future classrooms?
18. Who do you think is the best representative who meaningfully understands technology integration through this class and why?

Appendix L

Timeline of Data Collection Procedures


The Preliminary Phase
Data Sources
• Week 1: Introduction
• Weeks 2-3: Productivity Tools (Microsoft Office)
• Weeks 4-5: E-portfolio (Dreamweaver)
• Interview I
• Information sheets
• Assignment artifacts
• Course handouts
• Field notes
Web-enhanced CBR Activities
• Weeks 6-7: (Web-enhanced CBR activity I) Inspiration
• Weeks 8-10: (Web-enhanced CBR activity II) PowerPoint Game
• Weeks 11: Web resources
• Weeks 12-14: (Web-enhanced CBR activity III) WebQuest
• Weeks 15-16: (Web-enhanced CBR activity IV) Microteaching
• CBD report I
• Interview II
• CBD report II
• CBD report III
• Assignment artifacts
• Course handouts
• Peer feedback results
• Field notes
• Microteaching video tapes
• Microteaching feedback
• Microteaching reflection
The Final Phase
• Week 1-4 after the semester
• Interview III
• Interview with the Instructor
• Assignment artifacts
• Course handouts
• Course evaluation result
• E-portfolio reflection

Appendix M

List and Details of Categories, Subcategories, and Descriptions (Chap 3 & 4)

Educational roles of technology	**Strategies**
Purposes of computer use ▪ Productivity ▪ Motivation ▪ Learning content ▪ Learning thinking skills Importance of computer use ▪ Computer use as extra ▪ Computer use as helpful	Scenario work ▪ Using preference ▪ Using experience ▪ Characterizing Case analysis ▪ Characterizing ▪ Comparing Planning & Development ▪ Characterizing ▪ Comparing ▪ Envisioning ▪ Collecting Reflection and transfer ▪ Lessons learned ▪ Self-inducting ▪ Applying
Critical concepts	**Use of Web-enhanced CBR activities**
Teachers' roles ▪ As a facilitator ▪ As a lesson planner ▪ As a computer user Students' characteristics ▪ Ability of using computers ▪ Ability of doing activity ▪ Motivation Pedagogy ▪ Group work ▪ Research ▪ Searching resources ▪ Lecture (presentation) Content Curriculum standards Access issues Technical problems	CBR activities as useful CBR activities as not useful CBR activities as catalyst CBR activities as framework

Category	Subcategory	Description	Example quotes
Purpose of computer use	Productivity	Using computers for administration and convenient production, such as creating a PowerPoint presentation, newsletters, and seating charts; typing (word processor); searching for information	Number one, in writing papers they have Word or different programs to help them write and help spell things right and check their grammar.
	Motivation	Using computers for students' attention; interactive learning; and interesting learning	I think it makes it more interesting and when you are looking up things on the Internet.
	Learning content	Using computers for students' understanding of content, such as longer retention of content and easy understanding of content	They like using technology and computers and they enjoyed that, so to put reading and technology together and keep them busy but still be learning.
	Learning thinking skills	Using computers for learning how to think and learn	It is forcing the students to use their reasoning and deductive skills to answer important questions.
Importance of computer use	Computer use as extra	Supplementary to non-technology lesson and not contributing to learning	If you have that, it is just sort of an extra boost in a way, like people become "oh, this is something different today..."
	Computer use as helpful	Embedded as part of lesson activities and contributing to learning	I don't think it is as much that it is going to replace the teacher but it is going to aid her to enhance students' learning capabilities.
Teachers' roles	As a facilitator	Roles related to implementation of technology, such as facilitating students' learning seeing if students are following lesson activities and appropriately using technology; providing clear directions of how to do so	The teacher did not give them roles, and they had to work out who did what by themselves. Searching for graphics and clipart pictures on the Internet also became a problem because inappropriate material came on.
	As a lesson planner	Roles related to the development of lessons and materials, such as logically organizing students' activities and allocating time for lesson activities	If it takes you ten years to get the kids to the computer lab and get them situated, then you'll figure out if that is worth it or if you need to rethink your lesson plans.
	As a computer user	Roles related to teachers' computer skills, such as using the complicated functions of PowerPoint, and fixing	The game is surprisingly more complex than it sounds! Having to create and fix small problems- i.e. like buttons that don't work--

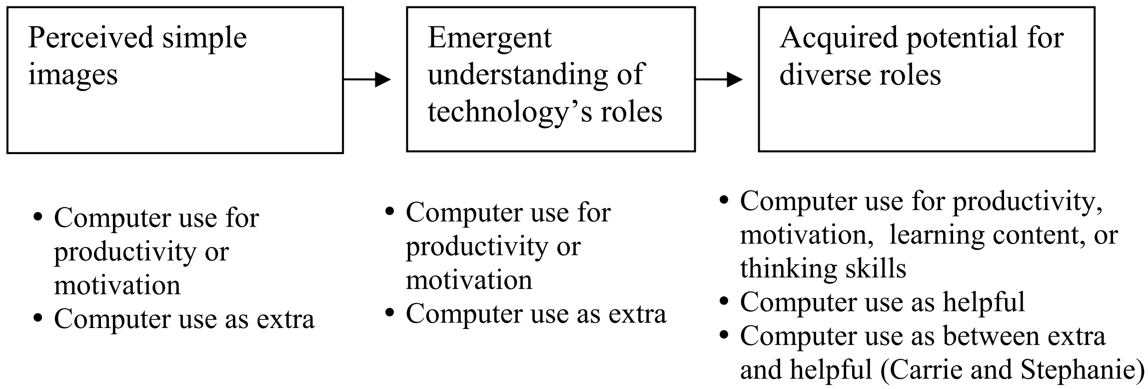
		technological problems	can be time consuming.
Students' characteristics	Ability of using computers	Students' ability to use computer programs or the Internet	My target students will be middle school-aged special education students. They are not very familiar at all with technology and only a few have used Microsoft word.
	Ability of doing activities	Students' ability to follow learning activities in lesson plans, such as taking roles and reading a book	It is hard for them to read stuff on the Internet because they can't read that well yet.
	Motivation	Students' preferences and interests	I know that if the kids saw the little pictures, they'd be excited and they would like to use that and use Kidspiration.
Pedagogical methods	Group work	Allowing collaboration or discussions as part of activities in lessons	Also in the classroom the teacher should divide the class into five equal groups and assign each group a part of the web.
	Research	Includes the procedure of research: searching for problems, building a hypothesis, searching for relevant information, and determining a solution	I will have my students use the web for guided research on the rocks. The microscope will also be used in examining the rock. I will probably have my students create a PowerPoint presentation …and let them look at rock from the microscope via the television or projector ...and why it would not on others.
	Searching resources	Simply searching for information in Websites, not including the procedure of research	The student will be introduced to what makes a mystery by researching various topics pre-selected by the teacher.
	Lecture (presentation)	Presenting and lecturing about content using technology such as PowerPoint, Inspiration, etc.	In 7th grade Social Studies Geography section, the students will use a combination of classroom lecture using PowerPoint.
Content		Considering appropriateness of the characteristics of content for technology use	Like a math game would be really good a timer but I'd have to figure out, okay, since I want this to be a timer thing, how to make it more challenging for them because if they get stuck on like 3 x 12, then that's going to take more time.
Curriculum standards		Considering the curriculum standards for decision making in computer-based or -enhanced lessons	The QCC reading objectives that this would address are reading comprehension skills as well as being able to recognize specific

			elements of a story.
Access issues		Considering a number of computers; planning the rule of how students use computer during lessons (in groups, individually, or taking turns)	There might not be enough money for computers or for software.
Technical problems		Considering technical problems; planning how to resolve the problems	Not knowing how to set it up and then with technology, it is not one hundred percent reliable. Like because the power can go out or the server could crash or your computer could get a virus.
Scenario work	Using preference	Deciding on scenarios and choosing ideas based on intuitive preferences	Well, I really love social studies and that is what I want to teach. And I really love geography.
	Using experience	Deciding on scenarios and choosing ideas based on K-12 or other relevant experiences	I sort of took things from like what I had done in high school so like doing debate, like building your own platform, I'd done something similar to that in a class before and I enjoyed it.
Planning & Development	Characterizing	Describing the nature of the concepts in situations, such as students' ability to understand and the characteristics of technology	I was just thinking that one class time and I was thinking about trouble makers I'd have in there or the variations of learning levels and I thought that would be too distracting for them.
	Comparing	Comparing situations by referring to several concepts	…in the end we will come back together to create the "superweb" by combining each group's smaller web. This would be done by me using a projector which is similar to Theresa's method of teaching. Another similarity is that the basis of the webs is a story that the class reads.
	Envisioning (implementation)	Picturing in one's head by anticipating how plans might go in a real classroom	I'm just really trying to picture how it would go and what it would look like so I could possibly, potentially save it and bring it back out and use it in the future.
	Collecting	Collecting parts to make details of the lessons by using the examples of other teachers' lesson plans and websites	It did not take me much time at all to find a WebQuest that interested me, and gave me ideas to sort of build off of that idea. I saw a WebQuest that was for like fourth graders who had to design a tour of Washington

			D.C., and that made me think that a tour of Georgia would be great!
Interweaving	Lessons learned	Identifying the lessons learned from their projects and addressing the possible solutions for the future.	The only difficulties I encountered were, one, coming up with an original idea. I had too many of them and was overwhelmed at my possibilities and which one to choose. If I was re-assigned this project, I would just pick an idea and go with it.
	Self-inducting	Verbally addressing their willingness to use computers or their projects in the future	I'm going to use and things I want to improve on, it sparked my interest in thinking of ways I can use this in my classroom.
	Applying	Showing application of course projects to new situations, such as other coursework and student teaching classrooms	I just told the teacher that I'd made a PowerPoint game in one of my classes and that if she gave me like their review questions that they do, I'd just put them on there and then we could play it in class.
CBR activity as useful		Perceiving CBR learning activities and their components as being useful for completing their projects or for understanding how to use computers for teaching	I felt like it taught me a lot about how to integrate technology in a classroom and how to be comfortable with it.
CBR activity as not useful		Perceiving CBR learning activities and their components as not being useful for completing their projects or for understanding how to use computers for teaching	…it wasn't my favorite thing to do but I understand the purpose of it [CBDT].
CBR activity as catalyst		Using CBR learning activities and their components to have new understandings and perspectives on teaching with technology	I'd never dreamed to do a PowerPoint game for a review. I wouldn't have thought I could create something out of PowerPoint.
CBR activity as framework		Using CBR learning activities and their components to understand their projects and organize their ideas	Seeing her and procedure and everything gave me a more comfortable feeling of "okay, I know how I'm going to do this."

Appendix N

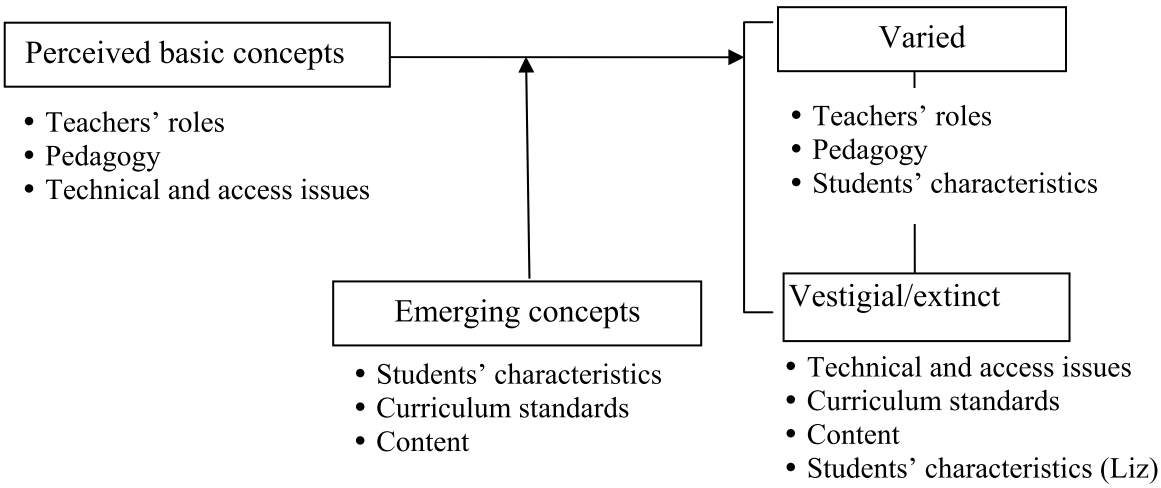
Change of Understanding About Educational Roles of Technology



Perceived simple images
Emergent understanding of technology's roles
Acquired potential for diverse roles
• Computer use for productivity or motivation
• Computer use as extra
• Computer use for productivity or motivation
• Computer use as extra
• Computer use for productivity, motivation, learning content, or thinking skills
• Computer use as helpful
• Computer use as between extra and helpful (Carrie and Stephanie)

Appendix O

Development of Critical Concepts for Teaching With Technology


Perceived basic concepts
• Teachers' roles
• Pedagogy
• Technical and access issues
Emerging concepts
• Students' characteristics
• Curriculum standards
• Content
Varied
• Teachers' roles
• Pedagogy
• Students' characteristics
Vestigial/extinct
• Technical and access issues
• Curriculum standards
• Content
• Students' characteristics (Liz)