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Conceptual change-based instruction and preservice teacher technology preparation: a collective case study

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preservice teacher technology preparation: A collective case study

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William Anthony Sadera

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Signature was redacted for privacy.

For the Major Program

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For the Graduate College
In Loving Memory of

Joseph A. Marino

And

Ferdinand Sadera
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Preparing preservice teachers to use computers effectively in teaching and learning is fundamental for significant educational reform. Often, preservice teachers possess traditional beliefs about teaching and learning and view the computer as a device to support traditional education. Because educational reform is, in part, contingent on the preparation of the next generation of teachers, it is imperative that teacher educators design and implement instructional strategies that help preservice teachers to develop comprehensive conceptions about classroom computer use. The purpose of this case study was to explore and examine the effects of a conceptual change-based instructional unit on preservice teachers' conceptions about teaching, learning, and the role of the computer in the classroom.

The data collected throughout the Instructional unit indicated that the extent of conceptual change experienced by each participant was unique based upon their existing conceptions, individual learning experiences, and motivation toward the alternative conception being taught. Based upon the analysis of each participant's progression through the conceptual change process and the collective data analysis, the instructional unit was effective in creating the conditions necessary for conceptual change to occur.
CHAPTER I. INTRODUCTION

"We are at the onset of a major revolution in education, a revolution unparalleled since the invention of the printing press. The computer will be the instrument of this revolution. By the year 2000, the major way of learning at all levels and in almost all subject areas will be through the interactive use of computers." (Alfred Bork, 1979)

Physically equipping K-12 classrooms with computers has been the primary focus of local and national efforts to bring schools into the Information Age. As a result, the ratio of computers to students continues to increase (Anderson & Ronnkvist, 1998), as does the power of computers available in classrooms (Anderson & Ronnkvist, 1998). However, little attention has been given to preparing teachers to effectively use classroom computers to improve teaching and learning. That is, those responsible for teacher development (i.e., colleges of education, school districts, area education agencies, state departments of education, etc.) have not created significant or meaningful opportunities for teachers to fully understand and explore the epistemological and pedagogical implications of classroom computers.

A growing demand for new teachers (AAHE, 2000) places a substantial portion of the responsibility to prepare teachers to meaningfully integrate computers into teaching and learning on colleges of education. Thus, it is paramount that teacher preparation programs develop and implement instructional programs that help future teachers fully understand ways in which computers can expand student learning. The purpose of this
chapter is to introduce a research study in which conceptual change-based instructional strategies were used to help preservice teachers develop more comprehensive conceptions about classroom computer use. This chapter consists of six sections: background, statement of the problem, purpose of the study, research questions, limitations of the study, assumptions, and definition of terms.

Background

"We are at the point in the history of education when radical change is possible, and the possibility for that change is directly related to computers" (Papert, 1980). Although many teacher educators agree with the predictions of educational futurists such as Seymour Papert and Alfred Bork, the methods we commonly use to prepare classroom teachers are based upon objectivist ways of knowing that do not take full advantage of the computer to expand learning. Moreover, because students enter teacher education programs with strong beliefs about teaching and learning, it is imperative that teacher educators acknowledge and address preservice teachers' existing conceptions.

The purpose of this section is to document the need for change in preservice teachers' technology preparation. In doing so, we provide an overview of the pedagogical conventions common to teacher education, summarize the literature on technology in teacher education, and introduce the conceptual change theory as a viable instructional model for preservice teacher technology preparation.
Pedagogy in Preservice Teacher Technology Preparation

In most institutions, new teachers are prepared to integrate computer-related technologies into the classroom using traditional teacher-centered instructional methods, such as lecturing. Furthermore, rarely do current instructional practices in teacher education openly or directly confront and challenge the beliefs about teaching, learning and technology that preservice teachers bring into teacher education courses. As a result, preservice teachers use their existing beliefs about teaching and learning to study and understand pedagogy (Tillema & Knol, 1997).

Often, when preservice teachers enter teacher education courses, they possess beliefs about teaching and learning that are teacher-centered and behaviorist (Knowles & Holt-Reynolds, 1991; Tillema & Knol, 1997; Niederhauser, Salem & Fields 1999). That is, before receiving formal instruction in pedagogy, preservice teachers often believe that the role of the teacher is to deliver information to students. In addition, preservice teachers believe that, as a result of the teacher delivering information, students learn by memorizing the information or using the information in the manner they had been told. When preservice teachers enroll in teacher education courses, they rely on these beliefs to understand pedagogy. Furthermore, when behaviorist methods are used to instruct future teachers, their behaviorist pedagogy is reinforced and strengthened (Knowles & Holt-Reynolds, 1991; Tillema & Knol, 1997; Niederhauser, Salem & Fields 1999).

In the worst case where instruction is teacher-centered and lecture-based (i.e., behaviorist), preservice teachers’ existing behaviorist beliefs are reinforced by the didactic instruction they receive in teacher education. In the best case where constructivist,
student-centered instruction is modeled (but preservice teachers' existing behaviorist conceptions are not directly addressed), preservice teachers adapt constructivist teaching methods into their behaviorist beliefs about teaching and learning. The adaptation of constructivist methods by preservice teachers who possess objectivist beliefs about teaching and learning is problematic because the preservice teachers do not change their beliefs about teaching and learning. Instead they augment instructional strategies to fit within their belief system. As a result, teacher preparation programs continue to produce preservice teachers whose objectivist beliefs narrowly define students’ roles in teaching and learning and limit their cognitive development. Moreover, these "new" teachers are ill-prepared to incorporate technology into teaching and learning in a manner that takes full advantage of the computer.

Technology in Teacher Education

Several research studies, of varying scales, investigating the preparedness of new K-12 teachers, indicate that teacher preparation programs are not providing instruction that adequately prepares teachers to effectively integrate the computer into the classroom (Quinn & Strudler, 1999; Willis & Mehlinger, 1996; Wetzel & Strudler, 1999). In a survey commissioned by the Office of Technology Assessment, Willis, Austin, and Willis (1994) found that preservice teachers believed they were poorly prepared to integrate technology into the K-12 curriculum. The majority of respondents stated that technology was not a concern in student teaching placement; furthermore, less than 25% of the preservice teachers were required to integrate technology into a lesson during their student teaching experience (Willis et al. 1994).
"Students studying to become teachers are not only in the role of learners, but also [they] are pivotal in determining the future role of computers in education" (Byrum & Cashman, 1993, p. 262). If computers in education are to meet the needs and expectations of society and educational futurists, the next generation of teachers must be prepared to use the computer as a tool to enhance their teaching and expand student learning.

In their study of 436 preservice teachers, Byrum and Cashman (1993) found that the majority of preservice teachers believed they were well prepared to use computers. However, their preparedness was expressed in reference to software categories such as: tool software, electronic communication software, drill and practice software, and software selection. It is significant to note that these preservice teachers did not describe their preparation to use computers in the classroom in terms of the computer's impact on teaching and learning, rather their preparedness was expressed based on their computer proficiency.

Byrum and Cashman (1993) found that, after receiving formal instruction about classroom applications of computers, preservice teachers maintained traditional views of a teacher-centered classroom and preferred to use the computer as a supplement to instruction. Byrum and Cashman (1993) suggested that insufficient computer modeling by teacher educators and inadequate constructivist-based computer integration experiences influenced this behaviorist attitude toward computer use in instructional situations.

Wetzel and Strudler (1999) examined four teacher education programs considered to be exemplary in integrating technology into teacher preparation. In their study, Wetzel
and Strudler (1999) argued that the four selected programs were dedicated to making technology an integral part of preservice teacher preparation. The guiding question for this research study was "what are the important pieces of the puzzle that make up current technology integration efforts at these sites?" The researchers found that all four programs:

- modeled classroom use of technology by university professors and K-12 teachers;
- established course requirements for technology infusion (i.e., all teacher preparation courses must integrate computer-related technology); and
- incorporated distance technologies (Wetzel & Strudler, 1999).

According to Wetzel and Strudler (1999) and Mergendoller, Johnson, Rockman & Willis (1994), three ways to successfully integrate technology into a teacher education program are to use technology to: (a) make real world situations more accessible; (b) access and communicate human and data resources; and (c) enhance traditional teaching approaches and practices.

Although Wetzel and Strudler (1999) and Mergendoller et al. (1994) identified important characteristics of teacher education programs that successfully integrate technology, it is significant to note that these characteristics and recommendations are at the programmatic level. That is, the findings of Wetzel and Strudler (1999) and Mergendoller et al. (1994) do not specify or illuminate characteristics of teacher education curricula that help preservice teachers develop their conceptions about classroom computer use.
For teachers to more fully realize the pedagogical implications of the computer, there must be a change in the role of the classroom teacher and the computer (Cuban, 1986; Bednar, Cunningham, Duffy & Perry, 1992). Computer use in the classroom should not be viewed merely as a way to reinforce behavioristic teaching methods, rather computer use should change the nature of what is taught, what is learned, and how learning occurs (Thompson, 1989). Such a change may be difficult given the widespread use and acceptance of the teacher-centered model of instruction.

When teacher educators teach preservice teachers about technology integration, little time is spent connecting the underlying epistemologies needed to fully understand how to effectively teach with technology (Niederhauser, Salem & Fields, 1999). That is, preservice teachers may learn how to apply constructivist-teaching methods (such as cooperative learning and investigative or problem-based learning), but rarely do they fully understand the beliefs about teaching and learning upon which these methods are based. As a result they adapt or modify the constructivist methods they are taught, to fit into behaviorist ways of knowing, which inherently limit the role of the computer in teaching and learning (Niederhauser et al. 1999).

**Conceptions and Conceptual Change**

A conception is an idea or notion. The ideas, notions, or understandings about a specific topic or subject that students possess prior to formal instruction are considered preconceptions (Posner, Strike, Hewson, & Gertzog, 1982). The preconceptions that preservice teachers bring with them to teacher education courses can exert a powerful influence on what they learn and accept as valid knowledge (Tillema & Know, 1997;
Kagan, 1992). To help preservice teachers develop more comprehensive conceptions about teaching, learning, and classroom computer use, they must proceed through cognitive processes that cause them to confront and alter their existing conceptions.

The conceptual change theory describes a process whereby rational beings may alter or abandon existing conceptions for ones that are more widely supported by empirical evidence (Posner, Strike, Hewson, & Gertzog, 1982). Using conceptual change-based teaching strategies in the classroom offers opportunities for the exchange of beliefs and the sharing of knowledge between students and teachers (Tillema & Knol, 1997). Conceptual change occurs in four stages through which individuals need to progress to change their thinking: dissatisfaction, intelligibility, plausibility, and fruitfulness. Individuals will adopt a new conception if they become dissatisfied with their existing conception, find or develop a new conception that makes sense, solves the current problem, and also solves other related problems (Posner et al. 1982).

Experiences preservice teachers have in conceptual change-based learning environments provide opportunities for them to contrast new and alternative conceptions with their existing beliefs. Conceptual change-based instructional strategies can play a central role in helping preservice teachers to understand and accept constructivist epistemologies and teaching methods (Stofflett & Stoddard, 1994) and learner-centered uses of the computer.
Summary

The increasing presence of computer-related technology in K-12 classrooms and the growing demand for new teachers (AAHE, 2000) places a substantial responsibility on colleges of education to graduate new teachers who know how to meaningfully integrate computers into teaching and learning. Thus, it is imperative that colleges of education develop and implement instructional programs that help future teachers fully understand teaching and learning, and how the computer can be used to expand student learning.

Often, when teacher educators model constructivist, student-centered instruction, preservice teachers alter these constructivist teaching methods to fit into their existing behaviorist beliefs about teaching and learning (Niederhauser et al. 1999). This alteration of teaching methods is problematic because the preservice teachers’ fundamental beliefs about teaching and learning are not challenged. Furthermore, when preservice teachers adapt or alter teaching methods to be consistent with their existing behaviorist beliefs about teaching and learning, they graduate from teacher education programs and implement instruction in their K-12 classroom that is based upon behaviorist beliefs about teaching and learning.

The preconceptions about classroom computer use, teaching, and learning that preservice teachers bring to teacher education courses are strong and resistant to change (Tillema & Knol, 1997). In addition, they often have strong effects on what preservice teachers learn and accept as knowledge (Tillema & Knol, 1997; Kagan, 1992). To help preservice teachers develop more comprehensive conceptions about teaching, learning, and classroom computer use, they must proceed through cognitive processes that help
them to confront and alter their existing conceptions. The development and use of conceptual change-based teaching strategies in teacher preparation courses can help preservice teachers build constructivist beliefs about teaching, learning, and classroom computer use.

Statement of the Problem

Often, preservice teachers possess conceptions about teaching, learning, and classroom computer use prior to receiving formal instruction on these subjects. Current instructional practices in teacher education do not acknowledge or address these preconceptions. That is, few teacher education programs implement curricula that directly address the existing epistemological and pedagogical beliefs that preservice teachers possess. Although in many teacher education courses preservice teachers are taught constructivist teaching methods, their foundational beliefs about teaching and learning are never addressed, challenged, or changed. Moreover, little research had been conducted that examines instructional strategies that take into account and address preservice teachers' existing beliefs about teaching and learning when teaching preservice teachers about the role of the computer in the classroom.

Purpose of the Study

The purpose of this case study was to explore and examine the effects of a conceptual change-based instructional unit to help preservice teachers accept constructivist theories of teaching and learning and constructivist roles for the classroom.
computer. In doing so, the researcher developed and implemented a unit of instruction that applied the conceptual change process to help preservice teachers move from naive conceptions toward more advanced conceptions about classroom computer use.

Research Design and Guiding Questions

The research described in this paper was a qualitative case study. Because the intent of case study research is to describe a phenomenon (Merriam, 1998; Stake, 1998), guiding questions were used to direct the design and implementation of the instructional unit. The instructional unit created the context in which the phenomenon of conceptual change occurred. This case study was designed to explore the following questions: How effective is the Conceptual Change Instructional Unit (CCIU) in creating conditions necessary for conceptual change to occur? As a result of the preservice teachers' participation in the instructional unit, did the preservice teachers alter their conceptions about the role of the computer in teaching and learning?

To more specifically understand the CCIU and the experiences of the participants, three questions were used to guide this study and interpretation of data:

1. Did the participants become dissatisfied with their existing conceptions?
2. Did the participants make sense of the alternative conception?
3. To what extent did the participants acknowledge the viability of the alternative conception? (i.e., did the participants consider the alternative concept to be worthwhile, believable, and practical?)
Participant Researcher

The researcher for this study was also the instructor of the CCIU. Thus, the implementation of the instructional unit and the interpretation of the results of this study were subject to my perceptions, biases, beliefs, and perspectives. Because I believe that teaching is the dynamic, real-time art of sense making, in which the nature and direction of learning activities are determined by student actions, beliefs, and needs, I served as both the researcher and the instructor. This strategy was employed to better understand the effects of the CCIU and the experiences of the student participants.

I believe that students need to be physically and mentally engaged in classroom activities, and thus, I designed the CCIU based upon constructivist instructional strategies. The constructivist-based teaching methods employed within this unit were student-centered and required an atmosphere where students experience situations and participate in activities that promote an understanding of the phenomenon being taught. Furthermore, the CCIU was designed around the students' progression through the conceptual change process. As a result, I was able to manipulate the instruction to help the students build stronger understandings and conceptions about teaching, learning, and classroom computer use.

Assumptions

For this research study, the following assumptions were made. It was assumed that:

- conceptual change could occur in this context. That is, it was assumed that the CCIU, which was taught in five days, could provide the context needed for students to alter their conceptions.
• the preservice teacher participants were mentally prepared and intellectually mature enough to comprehend the concepts being taught.

• the preservice teachers had the ability to acknowledge and alter their initial conceptions about classroom computer use, teaching, and learning.

• the instructor conducting the CCIU had the ability to work with the preservice teachers' preconceptions.

Definition of Terms

The following terms are defined in relation to this research study:

**Acknowledgment** – A display of acceptance and understanding of the subject matter being taught.

**Conceptions** – Ideas and understandings that have been developed over time as a result of experience, observation, experimentation and thought (Hargrave, 1993).

**Conceptual Change Instructional Unit (CCIU)** - A ten-hour unit of instruction about classroom computing designed to help preservice teachers progress through the four stages of the conceptual change theory.

**Conceptual Change Theory** - A theory that describes a process whereby rational beings may alter or abandon existing conceptions for ones that are widely supported by empirical evidence (Posner, Strike, Hewson, & Gertzog, 1982).

**Dissatisfaction** – A display of being displeased or unsatisfied. Showing interest in and acceptance of alternative conceptions being taught.
Excitement – A display of active participation and attention toward the subject matter being taught.

Motivation – A display of lively curiosity, concern, and interest toward the subject matter being taught.

Preconception – An idea or opinion formed in advance of or prior to formal instruction (Posner, Strike, Hewson & Gertzog, 1982).
CHAPTER II. LITERATURE REVIEW

Picture yourself walking down the hallway of a local middle school; beige painted walls, freshly waxed floors, student lockers, bulletin boards decorated with student projects, the smell of grilled cheese coming from the cafeteria nearby, and a slow walking student heading toward the restroom with a wooden hall pass. As you peer into a classroom window, you see a blackboard covered with information written in chalk. At the front of the room is a teacher's desk covered with papers, and a teacher lecturing to the students. Facing the teacher are rows of desks where seated students diligently take notes. On the walls are decorated bulletin boards; and finally, in the back of the room are several computers with blank screens covered with a light layer of dust from infrequent use.

Walking through the hallway of a teacher education program you see many features similar to those in a middle school; decorated bulletin boards and freshly waxed floors, a slow walking student headed for the restroom. But, as you peer into a classroom what you see is very different. You see desks organized in groups of four, a computer in the center of each group, and students working together in pairs. You hear the clamor of voices and discussions as the teacher roams from group to group. Toward the front of the classroom another group of students prepares for a presentation.

Both scenarios are within familiar environments and have similar goals; yet they are different. Both classrooms are focused on student learning, and in both students are seated at desks working diligently toward a goal set by the teacher. But, the activities in each classroom are guided by very different beliefs about teaching and learning. In the K-
12 classroom, the teacher is implementing behaviorist, teacher-centered instructional strategies. In the teacher preparation course, the teacher is implementing constructivist, student-centered instructional strategies. These two teaching strategies are quite different and are based upon fundamentally different beliefs about teaching and learning.

The purpose of this literature review is to set a foundation for arguing that the current instructional methods used in most teacher preparation programs do not effectively produce teachers who accept and understand constructivism and possess comprehensive beliefs about teaching, learning, and classroom computer use. This literature review discusses the presence of computers in today's classroom, preservice teacher technology preparation, and the conceptual change process. This literature review describes how preservice teachers proceed through their teacher preparation programs and alter what they learn about teaching and learning to fit within their existing beliefs. This chapter consists of seven sections: Schools in the Information Age, Technology Diffusion and Teacher Preparation Programs, Preservice Teacher Preconceptions About Classroom Computing, Teaching and Learning, Epistemology and Conceptual Change, Conceptual Change in Preservice Teacher Technology Preparation, and Summary

Schools and the Information Age

In a recent article, Carroll (2000) stated, "We have a unique opportunity in education today. Massive funds are pouring into the technology infrastructure of K-12 schools. It is estimated that $7 billion a year is being spent to equip schools with infrastructure, networking, and hardware" (p. 1). As the presence of computer-related
technology grows in the K-12 environment, current and future teachers must be prepared to effectively integrate these technologies meaningfully into learning environments.

In the spring of 1998, Anderson and Ronnkvist surveyed 1,215 public, private, and parochial school principals and technology coordinators about the presence of computer-related technologies in schools. The survey collected data about student-computer ratio, types and quality of computers in schools, location of computers in schools, as well as other data regarding classroom computer use (Anderson & Ronnkvist, 1999). The results of this survey showed that the student to computer ratio has risen from 168:1 in 1983 to 6:1 in 1998. The researchers noted that this growth is likely to escalate because of falling desktop computer prices and growing interest in and funding of the Internet and telecommunication technologies. The research of Anderson and Ronnkvist (1999) also showed that schools have more powerful computers than they did in the past. Forty five percent of school computers were at the Pentium or Power Macintosh level.

This growth in the computer-student ratio and the increased presence of more powerful computers is exciting, but inherently creates questions and concerns. The question being asked most often is also the hardest question to answer. Are these computers being used to improve student learning? Carroll posed an interesting question:

If a teacher from the 1800s walked into a classroom today, could he or she substitute as a teacher? If so, why would that be possible? Perhaps the educators of the 1800s were able to anticipate the needs of the 21st century and designed a system that perfectly fits our education purposes today. The other possibility is
that our industrial era schools have not changed to keep pace with our current understanding of cognition and learning. (Carroll, 2000, p.2)

Despite current learning theories (such as Piaget's stages of cognitive development (1972), Bruner's discovery learning (1973), and Vygotsky's scaffold learning (Ormrod, 2000) and developments in information technology, the behaviorist instructional models of the industrial era continue to dominate education. It has been argued by many that the computer compliments and enhances the constructivist classroom by promoting the capabilities of the learner (Papert, 1980; Perkins, 1992; Jonassen, 1992; The Cognition and Technology Group at Vanderbilt (CTGV), 1991).

Currently, most classroom computers are used to support traditional methods of teaching and traditional definitions of learning. That is, in the classroom, computers are used to: present information via presentation software (e.g., Microsoft Power Point); practice basic mathematics skills via drill and practice software (e.g., Number Munchers); and maintain attendance and grades records via spreadsheet or database software (e.g., Microsoft Excel or Microsoft Access). Using computers for presentations, drill and practice, and grade books are efficient uses of the computer to support the teacher, but these types of uses do not significantly effect students' cognitive growth and development. Classroom uses of computers should not be viewed merely as ways to reinforce behaviorist teaching methods and make these methods more efficient, rather computer use should change the nature of what is taught, what is learned, and how learning occurs (Thompson, 1989). For computers to be used in a manner that significantly effects students' cognitive growth, there must be a change in the role of the classroom teacher, the
computer, and teaching and learning (Cuban, 1986; Bednar, Cunningham, Duffy & Perry, 1992).

Preservice Teacher Preparation and Technology

If, in K-12 classrooms, the computer is to be used to significantly effect students' cognitive growth, two changes must occur in the preparation of preservice teachers. Teacher educators must: 1.) develop instructional strategies that guide preservice teachers to build constructivist beliefs about teaching and learning and 2.) prepare future teachers to use the computer to support cognitive growth.

The idea of preparing future teachers to use computers effectively within a constructivist classroom is not new. But, more often than not, research has shown that the methods commonly used are not successful (Quinn & Strudler, 1999; Willis & Mehlinger, 1996; Wetzel & Strudler, 1999, Byrum & Cashman, 1993).

Technology Diffusion and Teacher Preparation Programs

Although preservice teacher technology preparation typically takes the form of a single course (Hargrave & Hsu, 2000), many teacher education programs have developed programs that integrate classroom computer use throughout the curricula. Based on the argument that single course approaches to teaching preservice teachers about how to integrate technology into the classroom will not suffice, Iowa State university created a teacher preparation program which made technology an integral part of the teaching and learning environment (Thompson & Schmidt, 1994). Iowa State University has been a leader in preservice teacher technology preparation for the past decade.
Thompson and Schmidt (1994) stated that the Iowa State University teacher preparation program was designed around three main components: a course in computer-related technology; computer-related technology experiences in foundations, methods, and field experience classes; and an optional minor in educational computing that includes eighteen credits of coursework in computer-related technology topics. In addition to the focus on integrating technology across the curriculum, the College of Education furnished all faculty with easy access to technology, offered strong support across all levels, and began a one-on-one mentoring program for all interested faculty (Thompson, Schmidt, & Hadjiyianni, 1995).

Based largely on the concept of teacher modeling, two more recent examples of technology diffusion throughout the preservice teacher curriculum include King's College (Drazdowski, Holdick, & Scappaticci, 1999) and Louisiana State University (Stuhlmann, 1999). Drazdowski et al. (1999) described a diffusion process whereby the teacher education faculty devised and implemented a three-year technology diffusion plan. The plan included components for hardware and software acquisition, faculty training, curriculum development, implementation goals, and assessment.

The diffusion process began by creating two computer laboratories for teaching. The teacher education department also provided two lap-top computers and an LCD screen that could be checked out by both students and faculty. In addition, the chairperson urged professors to organize their classes in a more student-centered manner and frequently model instructional computer uses throughout teacher preparation courses. Lastly, technology savvy faculty members acted as change agents to train other faculty
about the many ways of integrating computers into their classes. Drazdowski et al. (1999) argued that the presence of computers and modeling of computer use by teacher educators would help preservice teachers to develop stronger understandings of how to effectively integrate computers into the K-12 classroom.

Similar to the work of Drazdowski et al. (1999), Stuhlmann (1999) investigated the technology preparation of preservice teachers in a small teacher preparation program. Within the teacher education program, the preservice teachers' technology preparation consisted of a three-course sequence. The three courses focused on providing preservice teachers with models and experiences for integrating technology into their teaching. To accomplish this, preservice teachers worked on technology-based projects with elementary students. The goal behind this program was “to instill the concept of technology as part of normal classroom environments” (Stuhlmann, 1999, p.127).

To examine the impact of the three-course technology infusion initiative, Stuhlmann (1999) studied ten preservice teachers; five students were in the three-course program and five were not. The researcher collected data through interviews, observations, journal entries, and a ten-item impact survey. The research showed that, as a result of the program, the five preservice teachers who completed the three-course sequence changed their beliefs about classroom computing and teaching overall. This group also adopted a more student-centered approach to teaching, expressed more assurance in their teaching capabilities, were more comfortable with students, and were more comfortable with integrating the computer into the classroom than students who did not complete the three-course sequence (Stuhlmann, 1999).
On a larger programmatic level, researchers sought to identify characteristics of teacher education programs that have successfully integrated technology (Mergendoller, Johnson, Rockman & Willis, 1994; Wetzel & Strudler 1999). In a study initially conducted by Mergendoller et al. (1994) and replicated by Wetzel and Strudler (1999), four teacher education programs noted for successfully infusing technology throughout their teacher preparation program, were carefully examined. Using case study research methods, both Wetzel and Strudler (1999) and Mergendoller et al. (1994) argued that the four selected programs were dedicated to making technology an integral part of preservice teacher preparation. The guiding question for both studies was: "What are the important pieces of the puzzle that make up current technology integration efforts at these sites?"

The researchers found that all four programs: modeled technology use by university professors and K-12 teachers; established course requirements for technology infusion (to communicate and access information across the curriculum); and incorporate distance technologies (Wetzel & Strudler, 1999). According to Mergendoller et al. (1994), three ways to successfully integrate technology into a teacher education program are to use technology to: (a) make real world situations more accessible; (b) access and communicate human and data resources; and (c) help enhance traditional teaching approaches and practices.

These large-scale programmatic studies by Wetzel and Strudler (1999) and Mergendoller et al. (1994), although significant, do not address the fundamental issues related to how future teachers will implement technology in their regular instructional practices. That is, these studies at the programmatic level did not address instructional
issues that directly impact the nature and content of preservice teacher learning. Moreover, this researcher strongly disagrees with the recommendation of Wetzel and Strudler (1999) and Mergendoller et al. (1994) encouraging the use of technology to enhance traditional teaching practices. The use of technology to support traditional instruction does not provide the type of instruction necessary for preservice teachers to transform their behaviorist epistemologies about teaching, learning, and classroom computer use. The research literature at the programmatic level has established the knowledge base about technology infusion within teacher education programs. Yet, this research does not specify or document instructional methods effective for developing preservice teachers' constructivist beliefs. To help preservice teachers develop constructivist beliefs about teaching, learning, and classroom computer use, researchers must understand the preconceptions they possess when upon entering teacher preparation programs.

Preservice Teacher Preconceptions About Classroom Computing, Teaching and Learning

When teacher educators teach preservice teachers about constructivist instructional methods, rarely are the underlying epistemologies of constructivism addressed (Niederhauser et al. 1999). That is, preservice teachers learn how to apply constructivist teaching methods such as cooperative learning and investigative or problem-based learning, but they do not learn the beliefs about knowledge and learning upon which these methods are based. As a result, the preservice teachers transform the constructivist teaching methods to fit into their existing behaviorist beliefs about teaching and learning.
and implement lessons that support behaviorist ways of learning (Niederhauser et al. 1999).

Based on their pre-college learning experiences, preservice teachers often enter college-level instructional technology courses with personal theories about the role of computers in teaching and learning. As students in K-12 classrooms, preservice teachers typically have experienced didactic instruction. These experiences influence their formal study of teaching and learning during their preservice teacher preparation courses. Most preservice teachers believe that teaching is a process of delivering information to students and learning is memorizing information (Niederhauser et al. 1999). As the preservice teachers progress through their teacher preparation program, they adapt or alter what they learn about pedagogy to be consistent with what they already believe about teaching and learning (Niederhauser et al. 1999). Posner et al. (1982) described these existing beliefs as preconceptions, and they argued that preconceptions can be inaccurate, incomplete, and resistant to change.

If preservice teachers are to possess more comprehensive and constructivist beliefs about teaching, learning, and classroom computer use, they need to change their existing conceptions about teaching and learning and their underlying beliefs about knowledge. In most teacher education institutions, we use traditional teaching methods to prepare future teachers to integrate new technologies into the classroom (Knowles & Holt-Reynolds, 1991). By designing instruction about constructivism and not implementing constructivist strategies we are merely reinforcing the behaviorist conceptions that preservice teachers already possess. Rarely are the underlying epistemologies of constructivism or
behaviorism openly addressed in instructional technology courses for preservice teachers. In developing teacher preparation courses, we must design instruction that directly confronts the epistemological beliefs about teaching and learning that preservice teachers already hold.

Posner et al. (1982) argued that for students to change their existing conceptions, they must progress through a cognitive process whereby they become dissatisfied with their existing conception and find or develop a new conception that solves the current problems and also solves other related problems that the original conception could not solve. Thus, conceptual change process stems from epistemology and theories that describe how people develop knowledge.

**Epistemology and Conceptual Change**

Unlike traditional psychology (which is based on empirical science and post-positivist ways of knowing), epistemology is philosophical (i.e., based on the search for rational understanding) and is rooted in “the kinds of things that count as good reasons” (Strike & Posner, 1992, p. 150). To fully understand epistemology, we must discuss the composition of knowledge.

From a philosophical view, knowledge emerges from the complex structures of a person’s beliefs. Beliefs develop out of one’s experiences and behaviors that produce schemata with related associative networks or mental images (Bruner, 1972). These networks, then, represent the knowledge of an individual. For example, as a child grows he or she will learn what a pencil is. A pencil is a long, orange, hexagonal object that can
be used to draw or write. A pen is similar to a pencil in that it is used to draw and write, is long and hexagonal in shape, but uses ink. The experiences and ideas a child builds about pens and pencils, as well as related objects (i.e., crayons), are defined as that child's knowledge and schemata of writing and drawing instruments.

Strike and Posner's (1992) "good reasons" definition of epistemology stems from the assumption that beliefs are rationally based on life experiences and can be modified and assimilated. "Epistemology sought to specify the logical parameters of rational belief. Its chief task was to specify criteria that enable us to distinguish true or reasonable beliefs from false or unreasonable ones. Its method was analytic and a priori. Formal logic was the basic tool." (Strike & Posner, 1992, p. 150). Therefore, epistemology is not based on empirical evidence, but more specific, background-based, historical, and interpretive evidence.

Given the epistemological view of the nature, acquisition and development of knowledge, it reasonable, then, to explore its implications for teaching and learning. Students at all levels enter into formal learning situations with beliefs. These beliefs (whether directly or indirectly related to the topic of instruction) impact students' knowledge development. Although impossible to account for all their beliefs, it is only the naïve instructor who does not design instruction that takes into account students' beliefs and how their beliefs impact learning.

To help individuals alter their beliefs, the conceptual change model (Posner et al. 1982) described four stages through which learners must progress for accommodation or
assimilation of new knowledge to occur; they are dissatisfaction, intelligibility, plausibility, and fruitfulness.

1. The student must become **dissatisfied** with his or her current conception; he or she must experience the limitations of his or her conception to solve the problem.

2. The new conception must be **intelligible** to the student; the student must be able to understand how the procedures of the new conception solve the current problem.

3. The new conception must be **plausible**: the new conception must be believable by the student as a method to solve the specific problem as well as related problems within the domain.

4. The new conception must be **fruitful**: the new conception must be practical in solving the problem in order for a student to adopt it (Posner et al. 1982)

Dissatisfaction is the mental state of the student when he/she realizes that his/her current solution to a problem is not adequate. Dissatisfaction causes the student to question his/her existing conception. Without dissatisfaction, the student will not realize the benefit of restructuring his/her beliefs. Strike & Posner (1992) described dissatisfaction as critical to the student's reconceptualization of their ideas. The discrepancies that students experience between/within the old conception and the new provide motivation for the students to process the situation and change their ideas.

In addition to the student realizing that his/her old conception may not be appropriate to solve the problem, the new solution being offered to him/her must be intelligible, plausible, and fruitful. For the new information to be intelligible, it must make sense to him/her. For the new solution to be plausible, the student must reason that
the new conception could rationally be true. Unless the new idea is understandable and reasonable, the student will not be motivated to process it. That is, he/she may view the new solution as simply another way to solve the existing problem instead of a better way to solve the existing problem and related problems. If the student does not actively process the new conception and recognize its ability to solve the new problem better than the old conception, the student may assimilate the new and old conceptions and incorporate the two conceptions together (Posner et al. 1982). Dole and Sinatra (1998) stated that, "It is only through high metacognitive engagement that strong conceptual change is possible" (p. 121).

Lastly, for conceptual change to occur, the new conception must be fruitful. The new conception must be viewed as a conception that can solve multiple problems, including problems that the student could not previously solve (Posner et al. 1982).

**Conceptual Change in Preservice Teacher Technology Preparation**

Although most educational research concerning the conceptual change process has been in the area of science education, several researchers have investigated the change process in preservice teacher education (Niederhauser, Salem & Fields, 1999; Knowles & Holt-Reynolds, 1991; Dole & Sinatra, 1998; Tillema & Knol, 1997; Pintrich, Marx, & Boyle, 1993). The three research studies described below discuss specific instructional methods and strategies used to integrate the conceptual change theory into preservice teacher preparation courses. Within each of these research studies, the
researcher/instructor attempted to move preservice teachers' epistemological beliefs from behaviorist to more constructivist.

Knowles and Holt-Reynolds (1991) argued that to help preservice teachers become aware of their preconceptions about classroom teaching, preservice teachers must expand their abilities to reflect upon their experiences as students. What they know and believe about teaching is constructed from personal experience, not formal study. Because past experiences are powerful, students cannot be persuaded to change what they know and believe about schools, learning, and teaching. Preservice teachers' classroom experiences as students are far more powerful than the mere classroom discussion about teaching they experience in teacher education programs (Knowles & Holt-Reynolds, 1991). As teacher educators, we must first "give preservice teachers a basis for acknowledging and understanding their previously unexamined, tacit beliefs. Second, we must structure opportunities for preservice teachers to develop alternatives" to these beliefs (Knowles & Holt-Reynolds, 1991, p.103). That is, teacher educators must develop strategies that give preservice teachers new experiences as students. These new experiences must be based upon and laden with the teaching and learning principles we want them to use in future practice when they become classroom teachers.

Knowles and Holt-Reynolds (1991) described several classroom activities that can be integrated into preservice teacher preparation courses to help preservice teachers understand their existing beliefs and become motivated to accept alternative beliefs. The activities the researchers described were: autobiographical writing, field experiences and, peer support and observations.
Knowles and Holt-Reynolds (1991) reported that autobiographical writing helped preservice teachers: make records of their personal histories as they relate to school, teaching, and learning; make meaning of experiences, classroom activities, and theories learned; improve their writing skills; and share their personal histories and ideas with other students. In addition, autobiographical writing provided teacher educators with a window into preservice teachers’ perspectives about themselves and their thinking.

Field experiences offered preservice teachers a chance to test new instructional strategies in the safety of small groups or laboratory settings (Knowles & Holt-Reynolds, 1991). Field experiences allowed teacher educators to collect information about how the preservice teachers processed new knowledge and integrated it into their collection of pedagogical strategies (Knowles & Holt-Reynolds, 1991).

Peer support and observations provide preservice teachers with a vehicle to talk with each other about their experiences and to develop their pedagogical thinking. Knowles and Holt-Reynolds (1991) argued that peers play a major role in assessing each other’s performance and professional development. In addition, preservice teachers in a group discussion and peer evaluations may be more motivated to consider new or conflicting information they have disregarded in the past because they value their peers’ viewpoints (Dole and Sinatra, 1998; Knowles & Holt-Reynolds, 1991).

Similar to Knowles and Holt-Reynolds (1991), Tillema and Knol (1997) also described strategies for integrating the conceptual change theory into preservice teacher preparation courses. Tillema and Knol (1997) argued that new knowledge offered to preservice teachers in their preparation courses often remains external, inert, and does not
stimulate professional problem solving or pedagogical reasoning. Based on the work of Neale, Smith & Johnson (1990), Tillema and Knol (1997) developed a set of instructional materials that focused on the incorporation of student teachers' beliefs and conceptions about approaches to teaching. These conceptual change-based instructional materials consisted of five steps: 1.) activation of prior experiences, 2.) introduction of new information, 3.) active exploration, 4.) strengthening of understanding, and 5.) discussions and idea exchange.

The first step, activation of prior experiences and diagnosis of beliefs, offered new and challenging ideas to the students that had them consider discrepancies or problems with their existing conceptions about classroom teaching. This was done through student recollections of unsuccessful teaching experiences and showing examples of failed teaching situations. Tillema and Knol (1997) argued that having students recognize their own views within these failed teaching experiences allowed them to compare their current views with following alternative conceptions.

The second step, the introduction of new information and focusing of learners' own perspectives, fostered the students' recognition of alternative ways of dealing with classroom situations. Based on course readings about pedagogical styles, the students were asked to write critical essays. This step was meant to stimulate and motivate the students' beliefs and collect information about alternative solutions.

The third step called for active exploration of relevant information and construction of a personal knowledge base. At this step, the students studied the alternative solutions through various assignments. These assignments lead students to
more profound viewpoints and the adoption of particular courses of action that tested the alternative solutions. Data about students' progression through this process was collected through the use of logbooks, diaries, and learner reports.

Step four was described as a continuation of the previous step and allowed the students to build a stronger understanding of the alternative conception. This involved the students developing an understanding of the importance, necessity and relevance of the alternative viewpoint. This is a crucial point in the conceptual change process (Knowles & Holt-Reynolds, 1991). At this point, if students do not find the alternative viewpoint intelligible, comprehensive, and plausible, it will be assimilated and discarded (Tillema & Knol, 1997).

The final step was based on discussions referred to by the researchers as idea exchanges. These idea exchanges allowed the students to challenge the new conceptions and make them concrete fixtures in their pedagogical toolbox. This was done through classroom debates and discussion sessions. This last step also provided data used to determine whether or not the new conception survived the change process (Tillema & Knol, 1997).

Examining the application of the conceptual change process with preservice teachers in their teacher education class, Niederhauser et al. (1999) taught their preservice teachers using two discrete instructional methods. One half of the course was taught using constructivist instructional strategies and the other half using behaviorist instructional strategies. All students within the course participated in both halves of the course.
Each of the two halves had similar goals - that of developing an understanding of hypertext mark-up language (HTML). After both instructional strategies were implemented, the students discussed their appropriateness for the desired outcomes. The discussions were structured to help the preservice teachers reflect on the meaningfulness of the learning, the role of the student, and the role of the teacher within each instructional strategy. In addition, the components, approaches, and limitations of each lesson were discussed.

The lessons taught via the behaviorist instructional strategy were highly structured, teacher directed, and didactic. The lessons highlighted problems with behaviorist teaching methods and attempted to bring about dissatisfaction within the preservice teachers' beliefs about classroom teaching and learning. The lessons taught via the constructivist instructional strategy were based on a student-centered instructional model. This served to provide the preservice teachers with experiences as constructivist learners and presented alternatives to the didactic, behaviorist, instructional model. Niederhauser et al. (1999) argued that these two activities allowed the preservice teachers to experience differences between the two instructional approaches from the perspective of learners and reflect on the strengths and weaknesses of each.

The results of this research study showed that the students had a range of opinions concerning the value of the instructional activity. Niederhauser et al. (1999) reported that most participants had increased motivation and better understanding through the constructivist methods, but some students failed to see the connection between theory and practice. Furthermore, the researchers found that some students were unable or unwilling
to make connections between the readings and discussion about learning theory, personal learning experiences, and the instructional practices they observed (Niederhauser et al. 1999). Other students noted that the lessons were helpful in developing an understanding of the differences between behaviorist and constructivist approaches to teaching and learning. Niederhauser et al. (1999) argued that these students willingly engaged themselves with the course concepts being taught and demonstrated a "need for cognition". This "need for cognition" grew because students struggled to understand the connection between learning and instruction.

The activities and results described in the three studies above offer insight into the complexity of using conceptual change-based teaching strategies in preservice teacher preparation courses. In addition, these studies describe specific techniques in which the conceptual change process can be operationalized to help preservice teachers to form more comprehensive beliefs about teaching, learning, and classroom computer use.

Summary

The purpose of this chapter was to set a foundation for arguing that the current instructional methods used in most teacher preparation programs do not effectively produce teachers who accept and understand constructivism and possess broad beliefs about teaching, learning, and classroom computer use. This literature review discussed the presence of computers in today's classroom, preservice teacher technology preparation, and the conceptual change process. This literature review described how preservice teachers proceed through their teacher preparation programs and alter what
they learn about teaching and learning to fit within their existing behaviorist beliefs. That is, as students in K-12 classrooms, preservice teachers often experienced didactic instruction. These experiences are what preservice teachers base their understandings of teaching and learning on during their preservice teacher preparation courses.

To help preservice teachers develop more constructivist beliefs about teaching, learning, and classroom computer use, instruction must designed that directly confronts the preservice teacher’s existing beliefs. Posner et al. (1982) argued that in order for students to change their existing beliefs and conceptions, they must progress through a cognitive process whereby they become dissatisfied with their existing conception, find or develop a new conception that solves the current problems as well as solves other related problems that the original conception could not. This process described by Posner et al. (1982) is known as conceptual change.

Integrating conceptual change teaching strategies into preservice teacher preparation courses offer opportunities for the exchange of beliefs and the sharing of knowledge between students and teachers for the forging of an increased understanding (Tillema & Knoll, 1997). Several researchers (Niederhauser et al. 1999; Knowles and Holt-Reynolds, 1991; Tillema and Knol, 1997) have designed teaching methods that integrate conceptual change strategies with preservice teachers. The methods implemented in these research studies helped preservice teachers to move from behaviorist to more constructivist beliefs about teaching and learning.

By integrating conceptual change teaching strategies into our teacher preparation courses we can help preservice teachers to recognize differences between their existing,
often behaviorist conceptions and, new, constructivist, conceptions. Moreover, conceptual change-based teaching strategies can help preservice teachers to understand and accept constructivist epistemologies and teaching methods (Stofflett & Stoddard, 1994), learner-centered applications of the computer, and facilitate the adoption of more constructivist beliefs about teaching, learning, and classroom computer use by preservice teachers.
CHAPTER III. METHODS

Preparing preservice teachers to use computers effectively in teaching and learning is fundamental for significant educational reform. Often, preservice teachers possess traditional beliefs about teaching and learning and view the computer as a device to support traditional education. Because educational reform is, in part, contingent on the preparation of the next generation of teachers, it is imperative that teacher educators design and implement instructional strategies that help preservice teachers to develop comprehensive conceptions about classroom computer use. The purpose of this case study was to explore and examine the effects of a conceptual change-based instructional unit on preservice teachers' conceptions about teaching, learning, and the role of the computer in the classroom. In this chapter, the research methods used to conduct this case study are described. This chapter contains the following sections: guiding questions, research design, research context and procedures, instruments, data analysis, pilot study, the instructional experience, and summary.

Guiding Questions

This qualitative case study was designed to explore the following questions: How effective is the Conceptual Change Instructional Unit (CCIU) in creating the conditions necessary for conceptual change to occur? As a result of the preservice teachers' participation in the CCIU, did the participants alter their conceptions about the role of the computer in teaching and learning?
To more specifically understand the effectiveness of the CCIU, the following questions were used to guide this study and interpret the data.

1. Did the participants become dissatisfied with their existing conceptions?
2. Did the participants make sense of the alternative conception?
3. To what extent did the participants acknowledge the viability of the alternative conception? (i.e., did the participants consider the alternative conception to be worthwhile, believable, and practical?)

Research Design

Qualitative researchers are interested in understanding the meaning people have constructed about a particular phenomenon, the experiences they have had, and how they make sense of the world around them (Merriam, 1998). Qualitative research is an umbrella term, covering several forms of inquiry that help us to understand and explain the meaning of social phenomena within natural settings. In contrast to quantitative research, which takes apart a phenomenon to examine component parts or variables, qualitative research seeks to shed light on how all the parts work together to form a whole (Merriam, 1998).

Qualitative research integrates multiple methods, involving an interpretive, naturalistic approach to its subject matter (Denzin & Lincoln, 1998). That is, “... qualitative researchers study things in their natural settings, attempting to make sense of, or interpret phenomena in terms of the meanings people bring to them” (Denzin & Lincoln, 1998, p. 3).
To fulfill the purpose of qualitative inquiry, researchers deploy a wide range of methodologies, hoping always to get a better understanding of the phenomenon being studies (Denzin & Lincoln, 1998). “Qualitative research, as a set of interpretive practices, privileges no single methodology over any other” (Denzin & Lincoln, 1998, p. 5). Qualitative research has no theory or paradigm that is distinctly its own, nor does qualitative research have a distinct set of methods that are entirely its own. Yet, there are many forms of qualitative research, such as: ethnography, phenomenology, grounded theory, and case study (Denzin & Lincoln, 1998).

Because the present research study sought to examine the effects of conceptual change-based instruction within a conventional preservice teacher preparation setting, this research study is described as a qualitative case study. Stake (1998) discussed the complexity and focus of a case study.

A case study may be simple or complex. It may be a child or a classroom of children or a mobilization of professionals to study a childhood condition. It is one among others. In any given study, we will concentrate on the one. The time we may spend concentrating our inquiry on the one may be long or short, but while we so concentrate, we are engaged in case study. (Stake, 1998, p. 87)

More specifically, Stake (1998) described a case study with less interest in one particular case as a collective case study. It is not the study of a collective group of individuals but an instrumental study extended to several cases. In a collective case study, the cases are chosen because it is assumed that understanding them will lead to a
better understanding and better theorizing, about a still larger collection of cases or population (Stake, 1998).

Within the present research study, eight preservice teachers serve as the cases within the context of a teacher preparation course. The collective cases within this study were chosen because it was believed that understanding preservice teachers' ability to change their conceptions about teaching, learning, and classroom computer use would lead to a better understanding of how conceptual change strategies can be integrated into the preservice teacher preparation process.

The theoretical foundation of this research study is bound within the stages of conceptual change. That is, data were collected from each case throughout the CCIU, and were interpreted based on each case's progression through the stages of the conceptual change theory. The data collected through this study were used to interpret, individually and collectively, the preservice teacher's progression through the conceptual change process and the effectiveness of the CCIU.

Research Context and Procedures

During the first day of the 2000 summer semester, students enrolled in the CI 201: Introduction to Instructional Technology course were asked to participate in this research study. Every student that chose to participate in the research study was advised orally and in writing that their participation was voluntary and would have no effect on their grades in the course or their standing in the College of Education. In addition, each student received a $100 honorarium for participating in the study.
Later that day, students who chose to participate in the case study began attending the five-day, 10-hour Conceptual Change Instructional Unit (CCIU). The CCIU was implemented two hours each day for five consecutive days during the first week of the summer semester. Data for the research study were collected throughout the unit. At the onset of the first lesson, the Preconception Identification Survey (PIS) and the CCIU Preparatory Assignment were administered. Following completion of the preliminary instruments, the CCIU began. All eight students participated in each lesson of the CCIU and completed an exit interview.

Participants

The participants in this study were selected using unique purposeful sampling procedures. That is, the researcher sought to identify participants with unique characteristics (Merriam, 1998). The unique characteristics of the participants in this study were that each participant was a preservice teacher who had not taken an instructional technology course prior to participating in this study.

The eight participants in this study were volunteers from an introductory instructional technology course (Curriculum and Instruction 201: Introduction to Instructional Technology). Because the majority of students who attend this course are sophomore-level preservice teachers it was believed that these students would possess the unique characteristics sought after for this study.

Curriculum and Instruction 201 is a requirement for all students in the teacher education program. The purpose of the course is to help preservice teachers develop an understanding of and appreciation for the role of instructional technology in teaching and
learning. The course goals are as follows: after completing the course, students should be able to: determine effective applications of instructional technology in learning and teaching, acquire skills to use instructional technology in teaching and learning, and develop a personal philosophical position about instructional technology.

During the course, students gain knowledge of and skills in using computer-related technologies such as: telecommunications, interactive multimedia, tool software, software selection, computer ethics and equity, problem solving software, and digital video production. Throughout the course, students complete several projects that help them to strengthen their computer literacy as well as develop their views about integrating the computer into the classroom (Schmidt, 1999). Based on the results of two research studies (Neiderhauser, Salem & Fields, 1999; Sadera, 1997), it was believed that most preservice teachers who had not taken an instructional technology course, possess naïve beliefs about teaching, learning, and teaching and learning with computers.

**Conceptual Change Instructional Unit**

The goal of the CCIU was to facilitate and develop the conditions needed for the preservice teachers to alter their conceptions about teaching, learning and classroom computer use. The CCIU consisted of five lessons. These lessons were designed to help preservice teachers progress through the conceptual change process. The conceptual change process consists of four stages through which learners must progress for accommodation or assimilation to occur. An overview of the CCIU is presented below followed by a detailed description of each lesson.
To initiate the conceptual change process, the students began the CCIU by engaging in activities designed to help them identify and articulate their existing conceptions about teaching, learning, and classroom computer use. In the second lesson, the participants were introduced to a constructivist, student-focused example of teaching, learning, and classroom computer use. The constructivist, student-focused example served as the alternative conception and was intended to be a dramatic contrast to the learners’ existing conceptions. Activities in the second lesson were intended to develop conflict between the preservice teachers’ existing conception and the alternative.

In the third lesson, the students further explored the alternative conception and had the opportunity to make sense of the new idea and strengthen their understanding of it. In the fourth lesson, the students worked with constructivist-oriented software and developed lesson plans into which the software was integrated. This activity was designed to intensify the preservice teachers’ feelings of dissatisfaction for their initial conception and build a greater acceptance and motivation toward the alternative conception as a fruitful solution.

In the fifth and final lesson, the students compared and contrasted their initial conceptions of teaching, learning, and classroom computer use with those expressed in lesson four. The intent of this activity was to help the participants see the viability of the new conception in solving problems their initial conception did not solve. Table 1 provides a brief description of each lesson of the CCIU and the stage of conceptual change each lesson addressed. Below each lesson is described in detail.
<table>
<thead>
<tr>
<th>Lesson</th>
<th>Primary Conceptual Change Activity</th>
<th>Stage of Conceptual Change</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>In groups students brainstorm ideas about how to incorporate the computer into a classroom situation. Discuss ideas about what teaching and learning is in each of the scenarios designed by the preservice teachers.</td>
<td>-Identify existing conceptions.</td>
</tr>
<tr>
<td>2</td>
<td>After the instructor presents a constructivist-based example of classroom computer use, students discuss ideas about what teaching and learning is in this alternative scenario.</td>
<td>-Elicit conflict.</td>
</tr>
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<td></td>
<td></td>
<td>-Develop dissatisfaction with existing conceptions.</td>
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<tr>
<td>2 (assign</td>
<td>Following lesson 2, assign readings/activities that describe and promote constructivist approaches to classroom computer use.</td>
<td>-Intelligibility of alternative conception.</td>
</tr>
<tr>
<td></td>
<td>(ment)</td>
<td>-Plausibility of new conception.</td>
</tr>
<tr>
<td>3</td>
<td>The participants discuss, compare, and contrast differences of teaching, learning and computer use between student' designed scenarios, the constructivist-based example presented by the instructor, and the assigned reading examples. In addition, the class discusses differences between types of computer use.</td>
<td>-Elicit conflict.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Build dissatisfaction with existing conceptions.</td>
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<tr>
<td>4</td>
<td>The instructor presents several software programs that cannot be easily integrated in a traditional classroom and asks students to design lessons that integrate the software.</td>
<td>-Strengthen dissatisfaction with existing conceptions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-Intelligibility of alternative conception.</td>
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<tr>
<td></td>
<td></td>
<td>-Plausibility of alternative conception.</td>
</tr>
<tr>
<td>5</td>
<td>The class discusses the scenarios created by the students. Compares and contrasts differences between these lessons and the model lesson; reflect upon instructional experience.</td>
<td>-Intelligibility, plausibility, and fruitfulness of alternative conception.</td>
</tr>
</tbody>
</table>
Lesson 1. In the opening activity of the CCIU, the preservice teachers designed a classroom situation in which the computer is integrated to help students learn. In designing these model lessons, the students were asked to define teaching, learning, and the role of the computer and draw a picture illustrating the appearance of their classroom and the lesson they described.

After the students, in groups, brainstormed their ideas about how the computer might be used, they were asked to explain their ideas to the class. Common threads and themes existing between the model lessons described by each group were discussed and written on the board. This allowed the students to identify and recognize their existing beliefs about classroom and student organization, computer use, teaching, and learning. Recognition of pre-existing beliefs is an important step in the conceptual change process (Tillema & Knol, 1997). By identifying existing conceptions and incorporating those conceptions into instruction, the stage is set for the instructor to develop conflict with the new knowledge being taught (Pintrich, Marx & Boyle, 1993; Tillema & Knol, 1997).

Lesson 2. To elicit dissatisfaction and conflict with existing beliefs, students were presented with an alternative approach to integrating computer-related technologies to help students learn. Prior to formal instructional about classroom computer use, preservice teachers tend to have naive beliefs about classroom computer use and tend to have behavioristic views toward teaching and learning (Sadera, 1997). The alternative example was designed to integrate the computer into the classroom based upon constructivist beliefs about teaching and learning. The instructor taught the lesson and the preservice teachers
participated as students. Through a discussion, the preservice teachers described teaching, learning, and the role of the computer in the alternative example. The preservice teachers were then asked, “Is this learning? Is this teaching?” This activity helped to provide motivation and interest in the alternative, through discussion and intellectual arguing between peers. The quality of the discussion and arguing is a key factor in whether or not the students will be persuaded to change their minds and begin to accept the new concept (Dole & Sinatra, 1998). “Students in a group discussion may be motivated to consider new or conflicting information they have disregarded in the past because they value their peers’ viewpoints” (Dole & Sinatra, 1998, p.119).

Following this lesson, the preservice teachers were assigned several readings. The readings consisted of an article discussing the theories behind constructivist teaching and three example lessons. The students were asked to read the materials and to create a list of common characteristics and themes of teaching and learning across the example lessons and the alternative lesson they had participated in that day. In addition, for each of the reading assignments describe what the teacher is doing, what the student is doing, and what is the computer doing.

**Lesson 3.** The out of class assignments following lesson 2 provided the preservice teachers an opportunity to collect information about the alternative conception and begin to build a personal knowledge base of the alternative. The building of a stronger knowledge base about the alternative conception continues to stimulate dissatisfaction
with the old belief. Pintrich, Marx, and Boyle (1993) argue that the learners will behave much like scientists in that, as dissatisfaction grows, they will begin to search out new intelligible, plausible, and more fruitful constructs that balance the understandings of the concept being learned. Unless this new information is both understandable (intelligible), and credible (plausible), an individual will not be motivated to process it (Dole & Sinatra, 1998). In addition to the readings, as part of the out of class assignment, the students were to answer several questions in relation to the readings. During class the students discussed the similarities and differences between their model scenarios, the alternative scenario presented by the instructor, and the readings. In addition, the discussion began to focus on the role of the computer in the different scenarios as well as the differences between teaching and learning.

Lesson 4. As the participants develop a knowledge and understanding of the new concept, it is important that they continue to experience situations that demonstrate that the new concept is more fruitful than the old one. Moreover, it is important that the participants continue to be dissatisfied with the old concept so that the two ideas aren’t simply assimilated together. Dole and Sinatra (1998) describe this interaction between the learner and the concept being taught as “engagement.” Engagement is the level to which the students develop strategies of connecting and comparing the alternative concept and their existing conceptions.

In lesson four the students were to integrate several different pieces of software into a classroom-learning situation. The students were presented several software packages and asked to design instructional activities around one of the three of the pieces
of software. The software chosen could be easily adapted into a constructivist classroom, but would not fit well within a behaviorist framework. Practice in applying the alternative conception helps the participants to make the conception their own and discover its ability to be more fruitful than their existing conception (Dole & Sinatra, 1998).

Lesson 5. During the final lesson, the class discussed the scenarios designed in lesson four and were asked to describe the role of the teacher, the students, and the computer. Most importantly, the students were asked, “Why didn’t you solve this classroom situation with traditional methods?” This activity allowed students to think about and articulate their thinking and their problem solving strategies. In addition to the metacognitive processing, this lesson was intended to help the participants begin to acknowledge how these new teaching strategies solve new problems that the old conception did not. Throughout the discussion, the students were given opportunities to challenge the new approach and articulate their newly constructed knowledge. To help the readers of this dissertation more clearly understand the focus and content of the CCIU, a detailed description of each lesson is included in Appendix C.

Instruments

Throughout this research, data were collected using the following instruments: Preconception Identification Survey (PIS), the CCIU Preparatory Assignment, reflective journals, course interaction videotape, in-class/out-of-class assignments, and exit interviews. Each instrument is described below.
**Preconception Identification Survey**

To gather data about the beliefs preservice teachers possessed about teaching, learning, and classroom computer use, the Attitudes About Reality Scale (AAR) (Unger, 1986) and a modified version the Preservice Teacher Perceptions of the Impact of Computer use on Learning Scale (PTPICL) (Sadera, 1997) were used. These surveys were combined and administered as a single instrument - the Preconception Identification Survey (PIS). These instruments have been used in previous studies to measure preservice teacher beliefs about teaching, learning and classroom computer use and had a Cronbach alpha reliability coefficient of $r = .82$ for the PTPICL and $r = .64$ for the AAR (Sadera, 1997).

The PIS was specifically used to collect data about the participants' experience with computers in education, attitudes about computers in education, level of computer proficiency, preconceptions about classroom computer use, and attitudes about reality. The items of each section of the PIS were analyzed to provide descriptive data for each participant. The PIS is included in Appendix E.

**CCIU Preparatory Assignment**

Prior to participation in the CCIU, the participants were asked to complete the Preparatory Assignment, in which they each were to write their personal definitions of teaching, learning, and classroom computer integration. The Preparatory Assignment was used to collect data about the conceptions the participants possessed prior to participating in the CCIU.
Reflective Journals

Each preservice teacher participating in the CCIU was asked to complete eight reflective journal assignments throughout the instructional unit. These reflective journals were used to collect data about the preservice teachers' conceptions and help them to recognize their existing conceptions. Similarly, in their research, Knowles and Holt-Reynolds (1991) found that the use of reflective journals helped preservice teachers to internalize their experiences as well as make them known to themselves and others. A description of each journal assignment is included in Appendix G.

Videotape-Based Data

The implementation of the CCIU was videotaped. The videotapes were used to supplement data about students' participation and conceptual growth throughout the research procedure. That is, as part of the interpretation of each participant's data, the videotapes were reviewed to examine class participation, excitement, motivation and reactions that coincided with text-based data collection points.

Exit Interview

Following completion of the CCIU, a researcher, not previously involved in the study, interviewed each participant. The researcher collected impromptu data about the students' opinions of the effectiveness of the CCIU and their change in conceptions about teaching, learning, and classroom computing. Prior to conducting the exit interviews, the interviewer was given a list of questions, as well as background information about each participant. Every participant was asked each question on the list. In addition, several participants were assigned questions specific to them because of concerns stressed by the
researcher (e.g., "Ask Jen to describe her definition of the term facilitating, she often used it in her journals"). The interview questions are included in Appendix H.

Data Analysis

The qualitative data gathered throughout the study (via the journal assignments, video tapes, exit interviews, etc.) were analyzed using categorizing strategies, contextualizing strategies, and triangulation. Categorizing strategies are a way of organizing data based on themes within the data. These themes are drawn from the theory driving the study (Maxwell, 1996; Merriam, 1998). For this study, each participant's data were categorized based on the stages of conceptual change (i.e., dissatisfaction, plausibility, intelligibility, fruitfulness).

To reduce the likelihood of misinterpretation, triangulation strategies were also used. Triangulation is a method used to validate data interpretation (Stake, 1998; Denzin & Lincoln, 1998). Triangulation is the process of using multiple data sources to clarify meaning and support interpretation (Stake, 1998; Denzin & Lincoln, 1998). When interpreting the results, multiple data sources were used to support each conclusion.

Contextualizing strategies are a way to understand data within the environment from which it was collected (Maxwell, 1996). Contextualizing strategies are often used in analyzing case studies, profiles, discourse analysis, and narrative analysis. Contextualizing analysis focuses on understanding an individual's relationships that connect statements and events within the context of a coherent whole (Maxwell, 1996).
The most common contextualizing strategy is the use of a data analysis matrix or concept map. A data analysis matrix provides the researcher with a way to use predefined categories and themes in the data to organize the data around the research questions. In this research study, the data were categorized based on the stages of the conceptual change theory and CCIU activities that were designed to address each stage. In addition, the guiding questions for this research study were based on each of the stages of the conceptual change theory. That is, to explore each participant's progression through the conceptual change process the data collected from each activity was categorized and compared against the predefined data analysis matrix. The data were then interpreted to shed light on each of the guiding questions.

**Example Use of Data Analysis Matrix**

Table 2 shows a portion of the data analysis matrix. Within this portion of the matrix, the analysis of data from learning journal 2 (J2), lesson 3 (L3), lesson 4 (L4), lesson 5 (L5), the preparatory assignment (PA), and the exit interview (EI) were used to define the degree to which each participant acknowledged the alternative conception. The complete contextualizing data analysis matrix used in this study appears in Appendix I.

An example of data analysis done through the use of this matrix is provided through Heather's data. In describing her final lesson, Heather explained that the students would progress through the Spanish version of the story [on the CD ROM] (L5). Following the story, "the student's would practice their translating skills by writing a summary of what the story consisted of (J5)." During this activity, the teacher would act as a supervisor to ensure that students were staying on task and be available to help
Table 2. Data Analysis Matrix Example

<table>
<thead>
<tr>
<th>Guiding Question</th>
<th>Measurement/Scale</th>
<th>Behavior</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. To what extent did the participants acknowledge the viability of the alternative conception?</td>
<td>Strong acknowledgement</td>
<td>Expressed strong interest and motivation toward applications of alternative</td>
<td>JL2, L3, L4, JL4, L5, J5, PA, EI</td>
</tr>
<tr>
<td></td>
<td>Moderate acknowledgement</td>
<td>Understanding of alternative and moderate application interests</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weak acknowledgement</td>
<td>Acceptance of alternative</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No acknowledgement</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

the students and answer any questions that might arise (L5). She stated that, the computer would act as a "tool for learning" by providing all the information about the story, word pronunciation, vocabulary and verb tenses (L5).

During the exit interview, Heather explained, that participating in the research study "helped to open [her] mind to other possibilities besides teaching from a book or using flash cards.... I can branch out and use some technology and other teaching methods that [she] wouldn't normally consider (EI)." She stated that students learn better when the teacher relates to them (EI). The lesson that she designed during the fourth day of the unit had constructivist characteristics, but at its heart was student practice and the reinforcement of skills. Heather appeared to have an understanding of the alternative conception, but failed to completely implement it in designing her final lesson. Thus it was interpreted that Heather expressed moderate acknowledgment of the alternative conception's viability. Heather showed strong interest and motivation toward the alternative, but maintained her behaviorist tendencies in the application of it.
Pilot Study

Prior to beginning this study, the researcher conducted a pilot test of the CCIU with four preservice teachers. The students who participated in the pilot study completed a scaled down version of the CCIU, including four of the five lessons and their coinciding unit activities and journal assignments. The pilot served both to help the instructor/researcher become comfortable with the lessons and the lesson content as well as determine the effectiveness of the class activities and journal assignment's. Following the pilot, the researcher spoke with each of the pilot participants to discuss concerns about or problems with the journal assignments and classroom activities. The data collected from each instrument were also examined to ensure that the questions were understandable and the data gathered would be appropriate for examining the participants’ progression through the conceptual change process.

In addition to the pilot study, two experts in preservice teacher technology preparation reviewed the CCIU. Following a review of the CCIU, the experts and researcher met and discussed possible changes in the instruction. Revisions and changes were made to the CCIU according to the discussions, suggestions of the experts, and the pilot study. The specific changes made to the CCIU based on the pilot study and discussions with experts are presented in Appendix D.

The Instructional Experience

Teaching is a work in progress, and thus instructional plans are often altered during the teaching process. The purpose of this section is to provide details about the
implementation of the CCIU. This instructional process was no different. Several changes were made throughout the instructional unit, both in terms of timing and instruction. First, in the original plan, the consent form and the PIS were to be administered prior to the first class meeting. But, because of time constraints and scheduling problems, the consent form, the preparatory assignment, and the PIS were administered at the beginning of the first CCIU lesson. The administering of these instruments took slightly over an hour for every participant to complete. As a result, the entire instructional unit was behind one hour. Although this did not cause many severe problems, it did cause several lessons to end at different times than were planned. This also caused some changes in journal assignments.

Also, as in any class there were slight changes in several of the lessons as the unit progressed. The constructivist-based teaching methods employed within this unit were student-centered and ask that the instructor provide an atmosphere where students experience situations and participate in activities that promote an understanding of the phenomenon being taught. The CCIU was designed with the students' progression through the conceptual change process at its' focus. As a result, the instructor/researcher was able to manipulate the instruction to help the students to build stronger understandings and conceptions about teaching, learning, and classroom computer use. A complete description of the changes in each day's instruction appears in Appendix C.
Summary

The purpose of this chapter was to present the research methods used in this case study. This case study sought to understand the effects of a conceptual change-based instructional unit designed to help preservice teachers accept constructivist theories of teaching and strengthen constructivist beliefs about roles for the classroom computer. Eight preservice teachers participated in the week-long CCIU. Each participant attended all five lessons, took part in all of the unit's activities, and an exit interview. Throughout the CCIU, data were collected using a variety of qualitative and quantitative instruments. To interpret the data, qualitative data analysis methods, such as contextualizing, categorizing, and triangulation, were applied. The results of the study are presented in Chapters 4 and 5.
CHAPTER IV. RESULTS OF INDIVIDUAL CASES

The goal of this study was to explore and examine the effects of a conceptual change-based instructional unit to help preservice teachers adopt constructivist theories of teaching and learning and constructivist roles of the classroom computer. The research question explored in this case study was: how effective is the CCIU in creating the conditions necessary for conceptual change to occur? To more specifically understand the effectiveness of the CCIU, the following questions were used to guide this study and interpret the data.

1. Did the participants become dissatisfied with their existing conceptions?
2. Did the participants make sense of the alternative conception?
3. To what extent did the participants acknowledge the viability of the alternative conception? (i.e., did the participants consider the alternative conception to be worthwhile, believable, and practical?)

The purpose of this chapter is to present the results of the individual cases that comprised the case study. In this chapter, the results from the Preconception Identification Survey are presented first to provide background information about the preservice teachers who completed the CCIU. Next, the results of each participant are presented. Because the data analysis was organized to address the guiding questions, the results present each participant's: preconceptions, level of dissatisfaction, understanding of the alternative conceptions, and acknowledgement of the viability of the alternative conception. Finally a summary of the results concludes this chapter.
Results From Preconception Identification Survey

Prior to participating in the CCIU, each preservice teacher completed the Preconception Identification Survey (PIS). The results of the PIS showed that the participants' preconceptions about teaching, learning, and classroom computer use were consistent with the larger preservice teacher population. Similar to the findings of Sadera (1997), the results of the PIS showed that the participants rated themselves as having:

- eclectic attitudes toward computers in education (with a mean score of 3.26, measured on a Likert scale ranging from I don't know (1) to strongly agree (5)).
- low computer proficiency (with a mean score of 2.03, measured on a Likert scale ranging from no experience (1) to high proficiency (5)).
- eclectic and eclectic constructivist epistemological beliefs (with mean scores ranging from 3.57 to 5.04, measured on a scale where scores between 3.53 and 4.00 were eclectic attitudes about reality and scores ranging from 4.01 to 5.00 were eclectic constructivist attitudes about reality (Hannafin & Freeman, 1995)).
- naïve beliefs about the impact of classroom computer use (choosing reinforcing uses of the classroom computer as having the most impact on student learning on the Beliefs about Computer Use in Learning Scale (Sadera, 1997)).

A complete description of the results of the PIS is included in Appendix J. The results of each participant's conceptual change are presented in the next section. The qualitative case data are included in Appendix J. To clarify the data source, the coding system described in Table 3 is used throughout the presentation of the results of this study.
Table 3. Data Source Coding System

<table>
<thead>
<tr>
<th>Data Source</th>
<th>Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preparatory Assignment</td>
<td>PA</td>
</tr>
<tr>
<td>Lesson 1</td>
<td>L1</td>
</tr>
<tr>
<td>Lesson 2</td>
<td>L2</td>
</tr>
<tr>
<td>Lesson 3</td>
<td>L3</td>
</tr>
<tr>
<td>Lesson 4</td>
<td>L4</td>
</tr>
<tr>
<td>Lesson 5</td>
<td>L5</td>
</tr>
<tr>
<td>Journal Entry 1</td>
<td>J1</td>
</tr>
<tr>
<td>Journal Entry 2</td>
<td>J2</td>
</tr>
<tr>
<td>Journal Entry 3</td>
<td>J3</td>
</tr>
<tr>
<td>Journal Entry 4</td>
<td>J4</td>
</tr>
<tr>
<td>Journal Entry 5</td>
<td>J5</td>
</tr>
<tr>
<td>Exit Interview</td>
<td>EI</td>
</tr>
<tr>
<td>Preconception Identification Survey</td>
<td>PIS</td>
</tr>
<tr>
<td>Instructor/Researcher Observation</td>
<td>O1, O2, O3...</td>
</tr>
</tbody>
</table>

This coding system represents the sources of data used in the interpretations. Model Lesson was designed in Lesson 1, discussed in Lesson 2. Alternative Lesson was implemented in Lesson 3. Final Lesson was designed in Lesson 4, discussed in Lesson 5.

Holly

Holly was a sophomore in Secondary Education and Spanish who expressed moderate excitement toward education. Over the course of the CCIU, she became quite friendly with several of the other students and would occasionally practice her Spanish with William who spoke Spanish fluently. Holly rated herself as having medium computer proficiency, moderate attitudes about computers in education, and eclectic epistemological beliefs (PIS). Consistent with the guiding questions, Figure 2 illustrates the extent to which Holly accomplished each stage of the conceptual change process and the beliefs she held upon entering this research study. The details of Holly's progression through conceptual change are discussed below.
At the onset of the instructional unit, Holly expressed objectivist beliefs about teaching learning and classroom computer use. She expressed her existing beliefs about teaching and learning as the passing on of knowledge and the taking in of new ideas (PA). In her model lesson, she stated that the computer would be used to run a reinforcement game (L2) (see Figure 1). In addition, she stated that "the computer acted as a way [for the students] to review and practice [what they learned] (J1)."

During the discussion of the alternative lesson and example lessons from the readings, Holly made many comments about teaching, learning, and the role of the computer. As defined in the data analysis matrix, Holly showed strong dissatisfaction with her initial conceptions through her excitement and motivation toward the alternative. She used words such as: "real-world problems, creativity, problem solving, and trusting (L3)" to describe the alternative conception. Holly often offered opinions about the different characteristics of teaching and learning that distinguished the alternative lesson from the model lesson (L3). She stated that all of the participants' model lessons were similar, but the alternative lesson was "Like, outside of the box! It broke all the rules! It was fun and exciting and meaningful to the students (L3)." Moreover, Holly noted that within her model lesson, the activity was lead by the teacher; but within the alternative, the activity was centered on the student and on the student's learning (J3).

As the instruction advanced, Holly showed moderate recognition and understanding of the alternative conception, as defined in the data analysis matrix. This was evident through her ability to discuss and write about the alternative conception. In discussing the alternative conception, Holly described learning as the acquisition of
knowledge through self-exploration, teacher-lead activities, and discussion (J4). Holly spoke of teaching as "guiding self-exploration rather than the transmission of facts (J4)." Holly stated that in her model, "the computer was used more in a drill-like fashion.... In the [alternative] lesson, the computer was used as an actual teacher while the real teacher played more of a passive, ask-if-you-need-me role. The program didn't use the memorization/drill-like things as in [our model], but rather it was an interactive program where the students were able to learn things on their own (J3)." Her ability to compare and contrast the lessons is indicative of her growth and recognition of the differences between her initial conception and the alternative.
Through her interest and motivation in class discussions and activities, Holly expressed moderate acknowledgment of the viability of the alternative conception and a moderate ability to apply the alternative conception. In describing her final lesson, Holly explained that the students would progress through the Spanish version of the story [on the CD ROM] (L5). Following the story, "the students would practice their translating skills by writing a summary of what the story consisted of (J5)." During this activity, the teacher would act as a supervisor to ensure that students were staying on task and be available to help the students and answer any questions that might arise (L5). Holly went on to state that the computer would act as a "tool for learning" by providing all the information about the story, word pronunciation, vocabulary and verb tenses (L5).

The lesson that she designed during the fourth day of the unit had constructivist characteristics, but at its core was practice and reinforcement of skills. Holly appeared to have an understanding of the alternative conception, but failed to fully implement it in designing her final lesson. During the exit interview, Holly explained, that participating in the CCIU "helped to open [my] mind to other possibilities besides teaching from a book or using flash cards.... I can branch out and use some technology and other teaching methods that [I] wouldn't normally consider (EI)." She also stated that students learn better when the teacher relates to them (EI).

As a result of participating in this instructional unit, Holly showed moderate change in her conceptions about teaching, learning, and classroom computer use. Holly observed and stated that the lessons she and her peers developed were significantly different than the alternative lesson, which she described as "outside the box" and
"meaningful to the students (L3)." Moreover, Holly noted that in her model lesson, the activity was teacher directed, but the activity in the alternative centered on the student and student learning (J3). The degree of conceptual change Holly realized was most evident the design of her final lesson and her exit interview. Holly's final lesson incorporated the computer in a constructivist manner, but required the students to practice their translation skills in a reinforcement activity (L5). Holly indicated that the CCIU opened her mind to instructional methods besides teaching from flash cards or a book (EI).

Figure 2. Stages of Conceptual Change Accomplished by Holly

Tammy
t

Tammy described herself as a fifth-year senior studying to be a secondary education teacher. She was a History major who decided to earn acquire a teaching degree. Tammy was a shy and quiet student who appeared to be cautious about using computers in education. At the onset of the instructional unit, she was hesitant to express
her thoughts and ideas; but as the research continued, she became more open with her peers. She rated herself as having high computer proficiency, moderate attitudes about computers in education, and eclectic constructivist epistemological beliefs (PIS). Consistent with the guiding questions, Figure 3 illustrates the extent to which Tammy accomplished each stage of the conceptual change process and the beliefs she held upon entering this research study. The details of Tammy's progression through conceptual change are discussed below.

Tammy began the instructional lesson expressing holistic beliefs about teaching, learning, and classroom computer use. Her beliefs were holistic in that she saw teaching as a combination of delivering information and creating environments to acquire information. Similarly, she viewed learning as creating understanding and the taking in of information. Tammy described teaching as "sharing knowledge [and] experience[s] with someone (students) who [did not] yet have that knowledge (PA)." In describing learning, Tammy stated that, "learning is when you acquire new knowledge or experience something new and are able to attain and apply what you saw, read, heard, or experienced to your way of life (PA)." In describing the role of the computer in her model lesson (See Figure 1), Tammy stated that, "the computer would be helping the students with the review, allowing the teacher more one-on-one time with each individual student (L2)."

Following the alternative lesson, Tammy expressed moderate to weak dissatisfaction with her existing beliefs, as defined by the data analysis matrix. This was evident through her understanding and acceptance of the alternative. Following the discussion about the alternative conception, Tammy described teaching as "when [the
teacher] gives students the tools necessary for learning a skill or solving a problem, but let[s] them explore and discover the answers on their own [and acts as] a guide and a resource (J4).

After the alternative lesson, Tammy described learning as discovering answers to questions and problems and applying this knowledge into situations in your life (L3). "When we started our (participants) lesson plans we were using the computer as a reinforcement, rather than... using it more as a tool to actually have [the students] learn for themselves and act as a resource (EI)."

Although the definitions Tammy developed after the alternative lesson appeared to be constructivist, other data suggested that her understanding and acceptance of constructivist views of teaching and learning was shallow (J4, L5). In addition, she did not have a complete understanding of the alternative conception.

Tammy improperly completed the journal assignment in which she was to compare the alternative conception with her existing conceptions, and thus the data from this journal entry did not clarify her understanding of the alternative conception. In addition there were questions as to what is meant by "teachers give students the tools necessary (J4)." Because she did not properly complete the journal assignment, her meaning of tools was not clear. There were no other data that clarified or elaborated on Tammy's definition of tools; in addition there were no other data that suggested Tammy had viewed the computer as a tool to help students learn. Moreover Tammy's reference to tool was not consistent with her preconceptions or the final lesson she designed.
In her final lesson, Tammy integrated the software, "Stanley's Sticker Stories" into a story writing activity. In describing this lesson, Tammy stated the "students would use prior knowledge of creating sentences and also of stories they may have read to create their own stories. The students would develop story-writing skills and strengthen their sentence writing skills (L5)." Tammy noted that the computer in this lesson would be "used as a tool for the students in writing and sharing their stories (L5)."

There was not enough evidence to conclude whether or not Tammy changed her conceptions about teaching, learning and classroom computer use. Tammy began the instructional unit expressing holistic beliefs (PA, L1). She completed the CCIU expressing holistic beliefs (L5). Tammy acknowledged a difference between her existing beliefs and the alternative, but she did not appear to change her definitions of teaching and learning as a result. Instead, she assimilated the alternative conception with her preconceptions about teaching and learning. Tammy stated that as a result of participating in this instructional unit she had become more aware of how to use the computer in the classroom (EI). "Learning can take place in many forms such as: hands-on activities, reading, listening, visually seeing an activity or a problem being solved (J4)." In this quote, Tammy combined both behaviorist and constructivist ideas in her understanding of learning. Lastly, Tammy's apparent assimilation of the alternative conception may be due, in part, to her weak participation in the instructional unit. For conceptual change to occur, the student must be a motivated, cognitively active participant in the learning process. Although she attended each lesson of the CCIU, Tammy did not appear to be cognitively engaged to the extent necessary for conceptual change.
Figure 3. Stages of Conceptual Change Accomplished by Tammy

Alexa

Alexa was a freshman in Special Education. Alexa was an average student who often seemed preoccupied. She only spoke when asked a question and wrote short answers in her journal. There were several times when I had to ask her to expand upon what she had written in her journal assignment because she gave so little information. As a result of taking the PIS, Alexa rated herself as having low computer proficiency, moderate attitudes about computers in education, and eclectic epistemological beliefs (PIS). Consistent with the guiding questions, Figure 5 illustrates the extent to which Alexa accomplished each stage of the conceptual change process and the beliefs she held upon entering this research study. The details of Alexa's progression through conceptual change are discussed below.
At the beginning of the lesson, Alexa expressed naive and behaviorist beliefs about teaching, learning, and classroom computer use. She explained that teaching and learning are the passing on and acquiring of knowledge (PA). In reference to classroom computer use, Alexa stated that it is very important for the students to learn how to use computers (PA). She saw the computer as a subject to be taught to students (not necessarily as a tool that can help to enhance teaching and learning). In addition, her existing conceptions were very strong. This was evident when she was designing her model lesson (Figure 4). She persuaded Todd, who had very different beliefs about teaching and learning, to design the lesson in a manner that was consistent with her existing conceptions (L1).

Following the alternative lesson, Alexa appeared to have weak dissatisfaction with her existing conceptions (as defined in the data analysis matrix). After the discussion about the alternative lesson, Alexa described teaching as "the facilitating of learning (J4)." Although the term facilitating is commonly used when describing the teacher's role in a
constructivist classroom, I was somewhat concerned with Alexa's use of the term. Earlier in the instructional unit, Alexa used the term facilitation along with term reinforcement (which is commonly used in behaviorist classrooms). Although Alexa used constructivist terms, in her discussion of the alternative lesson, Alexa also used other terms typically associated with constructivism, such as cooperative learning and problem solving. These terms had not been discussed in the CCIU, and thus, I was concerned that she may have gathered these terms from other environments and not fully developed an understanding of the ideas the terms represent. Furthermore, in creating new definitions, Alexa described learning the same as she had during the first class: "learning is the acquisition and application of knowledge (J4)."

As mentioned previously, Alexa was not the best student and more than once turned in journal assignments where she had written one or two sentences. Several times I asked her to take more time to answer the questions and explain what she meant in her own words (L3, L4).

Although some of Alexa's data were weak and incomplete, she showed moderate understanding and recognition of the alternative conception as the instructional unit progressed. This was evident through her ability to compare and contrast the two conceptions both in the video-taped classroom discussions and her journal writing. Alexa stated that in her model lesson, "the software used was a reinforcement game, but in the alternative lesson, the software had real-life applications and addressed many more avenues for learning (J4)." During the exit interview, Alexa explained "teaching isn't just lecturing (EI)." She stated teaching and learning can be hands-on and discovery-based
and students can actively participate in the learning process (EI). Although these are constructivist beliefs about teaching and learning, there was little evidence supporting her change in conception.

In reference to the internalization of the alternative conception as defined by the data analysis matrix, Alexa showed weak characteristics. Alexa exhibited little motivation and excitement toward the alternative conception throughout the unit (L1, L3, L4).

The lesson she designed during the fourth class lacked detailed information. The lesson she designed integrated "The Hot Dog Stand" software into an economics class. In describing the lesson, Alexa said "the students would be introduced to the software and then be asked to solve the problems that are provided through the software (L5)." In this lesson, she stated that, the students would develop computer, teamwork, problem solving, planning, and math skills (i.e., estimation, budgeting, inventory, and balancing of accounts) (L5). The lack of detail Alexa provided about how her final lesson would be implemented suggests that she did not internalize or acknowledge the viability of the alternative conception.

As a result of participating in the CCIU, Alexa began to use more constructivist terms, but she showed little evidence of change in her conceptions about teaching, learning and classroom computer use. She explained that she learned that "teaching isn't just lecturing (EI)." She stated that teaching and learning can be hands-on, discovery-based and allows students to be actively involved in the process of learning (EI). When asked if she had changed her ideas about teaching, learning and classroom computing, she said, "maybe a little (EI)." Alexa said she liked the idea of integrating teaching strategies
such as: "group involvement and hands-on experiences.... rather than just having them read a chapter and hoping [the students] absorb it (EI)."

I do not think Alexa fully understood the alternative lesson. She appeared to adapt constructivist ideas and terms (from the readings and classroom discussions) to fit into her existing conceptions about teaching, learning, and classroom computer use. Although the combining of the two conceptions is the process of assimilation, Alexa has not yet began to comprehend and build her own understanding of what the constructivist terms represent, and as a result has not assimilated. She is merely using the terms as part of her growing glossary of educational jargon.

<table>
<thead>
<tr>
<th>Conception Altered</th>
<th>Acknowledgement</th>
<th>Understanding</th>
<th>Dissatisfaction</th>
<th>Existing Beliefs</th>
</tr>
</thead>
</table>

Figure 5. Stages of Conceptual Change Accomplished by Alexa
Todd was a second year student majoring in Spanish and Secondary Education and a studious and well-spoken learner. Todd had very strong opinions about teaching and learning. In addition, his ideas about teaching and learning were broad and more comprehensive than most preservice teachers at his level. Todd rated himself as having low computer proficiency, moderate attitudes about computers in education, and eclectic constructivist epistemological beliefs (PIS). Consistent with the guiding questions, Figure 6 illustrates the extent to which Todd accomplished each stage of the conceptual change process and the beliefs he held upon entering this research study. The details of Todd's progression through conceptual change are discussed below.

Todd began the instructional unit with the most advanced and constructivist beliefs about teaching, learning, and classroom computer use, of all the participants in the CCIU. His definitions were constructivist and comprehensive. Todd defined teaching as "helping students discover knowledge about themselves, other human beings, life forms, and the universe. Teaching is assisting learners to use knowledge in creative ways. Learning is discovering the universe and making sense out of all the details (PA)."

When describing the role of the computer in the K-12 classroom, Todd stated, "computers are tool[s] that can be manipulated in varied ways to provide opportunities that are cost effective [and] that many students might not ever experience anywhere else (PA)." In addition, Todd strongly acknowledged his beliefs. This was evident in the presentation of the model lesson he designed with Alexa. In this presentation as well as in his journal, Todd explained his beliefs about how the lesson was conducted and how the
class was organized. Todd's description was in direct contrast with the description Angels gave. Alexa described teaching in their model lesson as "conveying information to the students [through] demonstrating and verbally reinforcing the concepts (J1)." Todd described teaching as "being a guide" and "steering the students in the right direction." "Students learn better if they uncover or discover the information for themselves rather than having it forced onto them (L2)" (see figure 4).

As the unit progressed, Todd continued to express constructivist beliefs in the class discussions, his model lesson and his final lesson. As a result, the level to which Todd became dissatisfied with his existing conceptions was minimal. That is, Todd's beliefs about teaching, learning, and classroom computer use were already similar to the beliefs expressed in the alternative lesson. Todd's conceptions were not contradictory to the alternative conception and thus were reinforced by the CCIU.

As defined by the data analysis matrix, Todd exhibited a strong understanding of the alternative conception. This was evident through his ability to discuss, explain, and apply the alternative conception. When discussing the model lessons and the alternative, Todd stated that within the alternative lesson, the computer was used to "collect, assemble, and manipulate information (L3)." "The computer is used as a tool to help the students learn (L3)." Todd acknowledged that, "teaching in [his] original model [lesson] was more traditional and less integrated...(J3)."

Todd's final lesson integrated storytelling software by Broderbund into a Spanish class. In describing his final lesson, Todd stated that, "the students will be given the [Spanish version of the] software and asked to listen to the story (L5)." While the
students were translating the story they would also be asked to make a list of the unknown vocabulary words (L5). As a result of this lesson the student would prepare/create: a vocabulary list of words she/he did not understand, a transcript of the story in Spanish, and a new story using the characters from the story and the vocabulary from their vocabulary list. Also in his lesson, Todd said the students would be grouped together to create a skit based on the story they wrote (L5). During the lesson, the teacher would help students who were having trouble with the computer or the software, evaluate students' progress, and assist in proper pronunciation practice (L5). In comparison to Tammy's lesson, (which was described as behaviorist,) Todd's lesson was not driven by the reinforcement of previous knowledge and practice-based. Todd's lesson was discovery and experience-based and student-centered.

As a result of participating in this instructional unit, Todd did not alter his conceptions about teaching, learning, and classroom computer use, but he expanded and strengthened them. Todd had already espoused constructivist beliefs at the beginning of the CCIU; this instructional unit appeared to reinforce and expand those beliefs.

Maryann

Maryann was a junior majoring in English and Secondary Education. Maryann was a hard-working student who participated in class. Although she often appeared sleepy, she always put forth a good effort in class activities and involved herself in class discussions. She rated herself as having low computer proficiency, moderate attitudes
about computers in education, and eclectic constructivist epistemological beliefs (PIS).

Consistent with the guiding questions, Figure 8 illustrates the extent to which Maryann accomplished each stage of the conceptual change process and the beliefs she held upon entering this research study. The details of Maryann's progression through conceptual change are discussed below.

Maryann entered the CCIU with more holistic definitions of teaching and learning than did most of the other participants. Her beliefs about teaching and learning were holistic in that she saw teaching as a combination of delivering information and creating environments to acquire information. Similarly, Maryann viewed learning as creating understanding and the taking in of information. Her holistic beliefs may be attributed to the fact that Maryann had completed several education courses prior to participating in the CCIU. The vocabulary she used to describe teaching and learning is evidence of her experience in education courses.
Maryann defined teaching as "the transfer of knowledge and ideas to others... in such a way that students just don't memorize facts and information, but understand... how to use the knowledge and/or ideas and apply it to life (PA)." She defined learning as "the understanding of knowledge and ideas well enough so that they may be applied to the [relevant] field of study and life (PA)." Her ideas about the role of the computer in the classroom were somewhat naive and based upon the idea that students need to be taught how to use the computer in addition to learning the subject matter. She stated that, "by having students work with computers in the classroom, they are being prepared for the working world (PA)." In addition, Maryann mentioned that she had "poor" attitudes toward using computers in education (EI).

In her model lesson, Maryann described the teacher as "a guide and motivator to help the students become familiar with multiplication (Figure 7.). In addition, the teacher must lay down the basic foundation of multiplication and act as a guide to [help the students] discover the steps used for multiplication (L2)." In describing this lesson, she stated that the role of the students "was to be attentive to the material discussed and put effort into practicing multiplication (J1)." She went on to note that, "the role of the computer [is] a reinforcer to the multiplication system.... The computer program was [used] as an alternative to flash cards and provide[d] a game-like set-up (J1)."

As the unit progressed, Maryann expressed weak dissatisfaction with her existing conceptions (as defined by the data analysis matrix). This weak dissatisfaction was mainly attributed to holistic beliefs. That is, the definitions of teaching and learning she provided in her model and final lessons, contained constructivist characteristics.
However, she did not employ the constructivist characteristics in her lessons; she employed behaviorist instructional strategies. Furthermore, her beliefs about classroom computer use throughout the CCIU were behaviorist.

Maryann acknowledged the constructivist influences in my teaching as well as in the alternative lesson (L3). "This [alternative] style of teaching is different from the forms of teaching many of us grew up with (L3)." She said that learning in the alternative lesson "is the exploration and discovery of knowledge that a teacher has provided (L3)."

Maryann understood the alternative conception. She appeared to use it to reinforce and expand her existing beliefs about teaching and learning and did not fully comprehend the basis of constructivist teaching. Maryann exhibited a strong ability to discuss characteristics of constructivism, but she had a weak understanding of the epistemology behind constructivism. She could integrate terms and ideas that describe constructivist teaching, but could not fully implement them into a lesson.

After being introduced to several software packages, Maryann designed an English lesson using the software Stanley's Sticker Stories. Maryann's final lesson began by having the teacher review the rules of writing a sentence, then having the students write sentences about what they had for lunch (L5). After the students wrote their sentences, Maryann explained that the teacher would introduce the software, and ask the students to sit at the computer and use the characters in the software to draw animated sentences (J5). She stated that in this activity, the computer acts as a motivator and "provides an alternative environment for practicing grammar and sentence structure skills (L5)." She stated that in
the lesson, the teacher's role is to "formally explain how a sentence is made and the components that go into making a sentence (L5)." The students' role in this class is to practice forming and writing sentences (L5).

Throughout her lessons, Maryann uses constructivist terms, such as guide and discover, but the ideas behind these terms were never implemented in her lessons. Maryann's model and final lessons were based on rote learning, in that the teacher told the students how to complete a task, followed by the students carrying out the task and practicing it through the use of the computer. It appeared that Maryann's understanding was based on the idea that constructivism is merely another teaching method and not a completely different way of thinking.

Prior to participating in the CCIU, Maryann already had begun to change her conceptions about teaching, learning, and classroom computer use. Maryann already had assimilated the constructivist teaching methods driving the alternative conception into her
existing behaviorist conceptions. That is, Maryann took the terms and methods used to describe a constructivist classroom and adapted them to fit into her existing behaviorist beliefs about teaching and learning. This was apparent throughout Maryann's data and aptly expressed in her exit interview. Maryann said she changed her ideas about classroom computer use. "I probably will use [the computer] a little more, but I still think that the teacher is the main source of information and knowledge and the computer can help reinforce [that knowledge]...(EI)."

Figure 8. Stages of Conceptual Change Accomplished by Maryann

Joann

Joann was a senior majoring in English and Secondary Education. She was a smart student and very excited about education. Joann consistently was out-spoken, energetic, and enthusiastic during class. She was well liked by the other students, was an active participant during the class discussions, and openly expressed her opinions. Joann
was the type of student that a teacher remembers. Joann rated herself as having medium computer proficiency, moderate attitudes about computers in education, and eclectic epistemological beliefs (PIS). Consistent with the guiding questions, Figure 9 illustrates the extent to which Joann accomplished each stage of the conceptual change process and the beliefs she held upon entering this research study. The details of Joann's progression through conceptual change are discussed below.

Joann began the instructional unit with constructivist ideas, but behaviorist-driven beliefs about teaching, learning, and the role of classroom computer. Through her experience in the teacher preparation program, Joann had studied and developed a knowledge of constructivism. But, within this research study, she was not categorized as having holistic beliefs about teaching and learning, because she had not assimilated constructivism and behaviorism into one belief. For Joann, constructivism and behaviorism were separate and unconnected. She had knowledge of and experience with constructivism, but she had not fully accepted the methods and philosophy that define constructivism.

Joann described teaching as "a process through which an individual aids another in realizing his or her own potential in learning. Teaching is not a static process, but is always changing and requires open-minded, resourceful, and helpful thinking (PA)." "Learning is a process through which an individual acquires knowledge, wisdom, and common sense...(PA)." When describing the role of the computer in the K-12 classroom, Joann stated, "computers can be very helpful as a means of presentation, dissemination, and facilitation (PA)."
In describing her model lesson Joann stated, "learning is internalized through exercises like hands-on activities, practice, and games. It is done through individual exercises and cooperative learning activities (L2)" (see Figure 3). Although Joann had been in the education program for several semesters and used constructivist terms (such as cooperative learning and hands-on activities), she espoused behaviorist beliefs about teaching and learning.

After participating in the alternative lesson, Joann showed moderate dissatisfaction with her existing conceptions (as defined in the data analysis matrix). Joann was a very active participant in class discussions and expressed excitement and motivation toward the alternative conception. In addition, she continued to explicitly differentiate between behaviorist teaching methods and constructivist. Throughout the CCIU, Joann used both constructivist and behaviorist terms, but did not combine the two.

Joann showed strong understanding and acknowledgment of the alternative conception. She described teaching in the alternative lesson as helping students to develop skills through interactive learning activities that encourage students to explore and discover on their own (J4). "Learning should be an active process with the 'learner' at the center of the action and as the individual around [which] all the activities, questioning and discoveries occur. Learning is taking what current knowledge and skills that an individual has and using those skills to take another step toward another level of knowledge, another level of skill, and another level of application through problem solving rather than memorization (J4)."
In her definition of the role of the computer in the alternative classroom, Joann stated, "the computer's role [in the alternative lesson] is to act as a tool through which the students and the teacher can enhance the learning process. It is an important aid insofar as it provides a platform for visual aids, a platform for organization, and a platform for [creating] a finished product (J3)."

After being introduced to the different software programs, Joann created her final lesson using "Hollywood High" and "Inspiration" in an English class. In describing her final lesson, Joann stated that the teacher would introduce the problem, the students would then work in groups to create a "survival situation" (L5). The idea for the "survival situation" would be brainstormed and mapped out using Inspiration (L5). After developing the idea, the students would use Hollywood High software to create and act out a play (L5). The teacher's role would be to: introduce the problem and the software, then motivate and support students (L5). In this lesson, the computer would act as a "tool that students could use to help them brainstorm, create, publish, and present their finished product (L5)." "The computer would [also] help students to assemble, manipulate, and organize information (L5)."

As a result of participating in the CCIU, Joann did not alter her conceptions about teaching, learning, and classroom computer use, but she appeared to be prepared to. Joann recognized differences between her existing conceptions and the alternative conception, but she did not recognize or acknowledge the extent or origin of those differences. Although her original definitions and descriptions of teaching and learning were behaviorist, in her final lesson, she appropriately implemented constructivist
strategies. Joann had begun the CCIU with an understanding of constructivism, but it was
abstract and unconnected to her beliefs about teaching, learning, and classroom computer
use. During the exit interview, she explained. "I came away [from this experience] with
more knowledge than I had previously, [I now have more of an] open mind as far as to
what I could possibly use technology for. If you sat me down and asked me how might I
use [the computer] in a classroom [lesson], I would probably just rack my brain.... Now I
at least have ideas and will try to think of different ways to integrate [the computer] into
the classroom (EI)." During the exit interview, Joann said that she was a senior and had
had experience with theories of teaching, but never saw how they fit within her teaching
repertoire. As a result of participating in the CCIU, she stated, "I learned a lot more about
applying those theories (EI)."

Figure 9. Stages of Conceptual Change Accomplished by Joann
Alyssa

Alyssa was a first year student studying Mathematics and Secondary Education. Alyssa carried an aura of nervousness and inexperience; she often took longer than the other students to complete the projects. She also was tentative when asking and answering questions. Alyssa was quiet during class discussions and when working in groups. Alyssa rated herself as having low computer proficiency, moderate attitudes about computers in education, and eclectic constructivist epistemological beliefs (PIS). Consistent with the guiding questions, Figure 11 illustrates the extent to which Alyssa accomplished each stage of the conceptual change process and the beliefs she held upon entering this research study. The details of Alyssa's progression through conceptual change are discussed below.

Alyssa began the CCIU with naïve beliefs about teaching, learning, and classroom computer use. Her beliefs were behaviorist and based on her K-12 classroom experiences (PA, L1, J1, EI). In her preparatory assignment, Alyssa described teaching as "the bestowing of knowledge to others (PA)", and learning as "the process of taking in information (PA)." She stated that the role of the classroom computer is to "enhance education" and should be used as a tool to expand on the basics (PA). In her model unit, Alyssa explained, "the teacher would explain the basics of multiplication and division to the students and go over their times tables (J1)." "In this manner, the computer is used to reinforce what the teacher had previously taught and the students had the opportunity to practice what they had learned (L1)."
After participating in the alternative lesson, Alyssa showed weak to moderate dissatisfaction with her existing conceptions (as defined by the data analysis matrix). She stated that learning in the alternative conception was "the process of taking in valuable information through experimentation and discovery that produces a sense of great accomplishment that has 'applicable-to-life' results (L3)." She stated that "in the model lessons [designed by the participants], the computer was used for games that drilled [lesson content] rather than encouraged discovery [of learning] (J4)."

As the unit progressed, Alyssa showed strong recognition and understanding of the alternative conception through her ability to discuss and write about the alternative as well as compare the alternative to her existing conceptions. Alyssa noted that in contrast to her model lesson, the students in the alternative lesson were in charge of their learning and the teacher acted as a guide and only intervened when necessary (i.e., students were having problems) (J3). She stated, the computer in the alternative lesson, "was used a tool that aided in problem solving and provided real-life application (J3)." During the exit interview, she stated that the alternative lesson showed her that there are different ways of teaching that were probably more effective than just standing there and lecturing to the students.

In her final lesson Alyssa integrated "The Hot Dog Stand" software into a business class. Alyssa applied the software in her final lesson in a constructivist manner. She explained that once the lesson was underway, the teacher would act as a coach and help the students with any problems they might be having solving the problem the software presented (L5). In this lesson, Alyssa said the computer provided a real-world situation
As a result of participating in the CCIU, it appeared that Alyssa exhibited a moderate change in her conceptions about teaching, learning, and classroom computer use. Alyssa stated that she changed her ideas about teaching and learning and was excited about the alternative conceptions. However, she also stated that "the computer [could] do a lot of the instruction (EI)." This was consistent with her final lesson where she had the students use the computer and solve the problems as the teacher acted as a coach (L5).

William

William was a graduate student studying Educational Computing. William had received his PhD. in sociology several years earlier from the State University of New
Figure 11. Stages of Conceptual Change Accomplished by Alyssa York. William was raised in Mexico and spoke English quite well although he had a heavy accent. In addition, he sometimes had trouble understanding what was expected of him with respect to the journal assignments. Throughout the CCIU, William often analyzed the instructional approach I used as well as the rationale for my actions. He sometimes asked questions that were not related to the CCIU. Several times I asked him to hold the questions and ask me after class. William rated himself as having low computer proficiency, moderate attitudes about computers in education, and eclectic constructivist epistemological beliefs (PIS). Consistent with the guiding questions, Figure 12 illustrates the extent to which William accomplished each stage of the conceptual change process and the beliefs she held upon entering this research study. The details of William's progression through conceptual change are discussed below.
William was not new to educational computing and had attended several instructional technology courses at the graduate and undergraduate levels. His previous exposure to educational computing instruction as well as the other graduate education he had received, effected his beliefs about teaching, learning, and classroom computer use.

At the onset of the instructional unit, William described teaching as "the activity by which knowledge is transmitted and facilitated through different persons involved in the teaching and learning experience (PA)." He stated that, "learning is the process by which we incorporate new knowledge about different subjects...(PA)." In discussing the role of the computer in the K-12 classroom, William noted that the computer "can facilitate the process of learning by providing access to different sources of information for the facilitating of new [more individualized] learning (PA)." In his model lesson, he stated that "the role of the computer in the lesson [was] to facilitate practice and introduction to new topics. It would change the dynamics of the class by forcing the class to find its [own] way of doing things. The computer in the classroom could break traditional models and give the teacher more flexibility (J1)" (see Figure 4).

William used the terms facilitate, practice, and transmit, interchangeably throughout the CCIU. I believe that William had heard these terms used in the educational computing classes he had taken in the past and assimilated them into his vocabulary. Furthermore, because English was not his first language, William may not have fully understood the meaning of the terms. For example, William noted that, the computer "can facilitate the process of learning [by] providing access to different sources of information [and] facilitating new forms of learning (PA)." William also stated that,
"the role of the computer in the [model] lesson [was] to facilitate practice and introduction to new topics (J1)."

Following participation in the alternative lesson, William appeared to be confused. At this point in the instructional unit, he did not appear to understand his existing conceptions or the alternative conception and thus dissatisfaction for his initial conception did not occur. His new definition of teaching and learning and his explanation of the characteristics of the alternative conception were not focused and were quite broad. After participating in the alternative lesson, William described teaching and learning as "a cooperative experience in which the boundaries between both are blurred. Both activities require imagination and creativity. Learning and teaching can be more meaningful when linked to real-world situations. In the process of teaching and learning, technology can play a very important role serving as a tool that facilitates the accomplishment of tasks [and] facilitates new forms of communications and access to information (J4)."

William's final lesson was constructivist. After being introduced to the different software packages, William designed a lesson that integrated "Imagination Express: Rainforest" software into a Social Studies lesson. The lesson began with the teacher asking the students motivating, low-level questions, then the students worked with the computer to gather information (L5). This activity was followed by a discussion connecting the answers to the opening questions with the information the students found and exploring new, more advanced questions (L5). In his description of the lesson, William stated "the technology is used to present the software program and allow the students to gain information about the Kuna [people]. It facilitates the role of the teacher
as the source of information (L5)." The last sentence of this quote illustrates William's confusion or misunderstanding of the term facilitate.

It appears that William did not alter his conceptions about teaching, learning, and classroom computer use. His beliefs about teaching and learning, were neither behaviorist nor constructivist, but an understanding that was specific to William. When asked if his ideas about teaching, learning, and classroom computer use changed as a result of participating in the CCIU, William said "I don't think they changed a lot (EI)." "I am curious about this [classroom computer use].... But, you have to contextualize where and when you use it.... For instance what constraints might [you] have, say you're teaching in a certain institution with certain rules and processes." William mentioned that he liked the idea of using technology in the classroom, but he also would consider using tradition technologies such as blackboards and overhead projectors (EI).

In comparison to the other preservice teachers, William brought rather complex conceptions about teaching, learning, and classroom computer use to the CCIU. William had a worldview that was unique because of his prior education and experiences with instructional technology. Although William stated that he learned a great deal from this experience, the CCIU was not designed for a student with his knowledge and experiences. Rather the CCIU was designed for preservice teachers with no formal instructional technology instruction and behaviorist beliefs about teaching, learning, and classroom computer use.
Figure 12. Stages of Conceptual Change Accomplished by William

Summary

The purpose of this study was to explore and examine the effects of a conceptual change-based instructional unit to help preservice teachers accept constructivist theories of teaching, learning, and constructivist roles of the classroom computer. This research study is bound within the stages of conceptual change, and thus the data were interpreted based upon each participant's progression through the stages of the conceptual change theory.

Based on qualitative data analysis methods (such as categorizing, triangulation, and contextualizing), the interpretations of the eight cases were presented in this chapter. The data indicated that the extent of conceptual change
experienced by each participant was unique based upon their conceptions prior to engaging in the CCIU and their individual learning experiences within the CCIU. In the following chapter the analysis of the collective case is reported.
CHAPTER V. COLLECTIVE CASE RESULTS

The purpose of this chapter is to present the results of the collective case study about conceptual change-based technology instruction. The research questions explored in this case study were: how effective was the Conceptual Change Instructional Unit in creating the conditions necessary for conceptual change to occur? and as a result of their participation in the instructional unit, did the preservice teachers alter their conceptions about the role of the computer in teaching and learning? In the preceding chapter, the results of the eight instances (i.e. cases) of preservice teachers' conceptual change about classroom computer use were presented. In this chapter, the results of the collective case are presented to directly address the research questions.

Collective Case Results

For a rational being to change their understanding of a phenomenon, Posner et al. (1982) argued that the individual must progress through four cognitive stages. The individual must become dissatisfied with their existing conceptions; find an alternative conception that is intelligible and reasonable for solving problems; and applicable to other related problems. To determine the effectiveness of the Conceptual Change Instructional Unit (CCIU) in helping the participants to progress the stages of conceptual change, the eight instances of the case study were analyzed collectively. That is, to better understand the effects of the CCIU, its impact on the participants as a group, was examined.
Based on the work of Sadera (1997), it was believed that the participants would begin the CCIU with naive and behaviorist beliefs about teaching, learning, and classroom computer use. Although many of the preservice teachers began this case study with similar preconceptions about teaching, learning, and classroom computer use, they were all at different stages in the development of their epistemological beliefs.

Prior to participating in the CCIU, Alyssa, Holly, Alexa, and Joann expressed behaviorist beliefs about teaching, learning, and classroom computer use. Tammy and Maryann expressed holistic beliefs about teaching, learning, and classroom computer use, and Todd expressed constructivist beliefs. (Although William participated in the instructional unit, his data were not included in the collective case analysis. William did not match the unique characteristics sought after when the participants were selected from the sample. William was not a preservice teacher and had extensively studied instructional technology prior to this research study. Because of this, he did not meet the sampling criteria and thus was excluded from this portion of the analysis).

Formal instruction in preservice teacher education typically occurs in groups or classes; yet each student in a class learns the course content in their own way and at their own pace. Furthermore, each student enters the formal learning environment with unique preconceptions about the topic of instruction. This was true in the CCIU. Because the participants entered the CCIU with different educational backgrounds and preconceptions, the extent of their progression through the conceptual change process varied. The type and strength of preconceptions the preservice teachers possessed also affected the degree of dissatisfaction the CCIU fostered. Figure 13 illustrates the extent to which the
collective case accomplished each stage of the conceptual change process and the beliefs each case held at the onset of this research study.

To address the two research questions explored in this case study, the data were organized around the stages of conceptual change. Thus, the collective case results are presented in three sections: dissatisfaction, understanding, and acknowledgement.

How Effective Was The Conceptual Change Instructional Unit In Creating The Conditions Necessary For Conceptual Change To Occur?

Dissatisfaction with Existing Conception

As defined in the data analysis matrix, dissatisfaction is exhibited through understanding and acceptance of the alternative conception, and motivation and excitement toward the alternative conception. The preservice teachers participating in the CCIU exhibited varied levels of dissatisfaction with their existing conceptions. Four participants (Todd, Alexa, Maryann, and Tammy) exhibited weak or no dissatisfaction with their existing beliefs. Three participants (Joann Holly, and Alyssa) exhibited moderate to strong dissatisfaction with their existing conceptions about teaching, learning, and classroom computing.

Holly showed the strongest dissatisfaction. During the discussion of the alternative lesson and example lessons from the readings, Holly made many comments about teaching, learning, and the role of the computer. She used words such as real-world problems, creativity, problem solving, and trusting to describe the alternative conception (L3). Holly, both in class discussion and her journal writing, differentiated between the
characteristics of teaching and learning as defined in the model lesson and the alternative lesson (L3). Holly noted that within her model lesson, the activity was lead by the teacher, but within the alternative, the activity was centered on the student and on the student's learning (J3). In addition, She stated that, all of the participants' model lessons were similar, but the alternative lesson was "Like, outside of the box! It broke all the rules! It was fun and exciting and meaningful to the students (L3)." Holly's dissatisfaction with her preconceptions was exhibited through her strong understanding, acknowledgement, and motivation toward the alternative conception and her ability to implement constructivist strategies into her final lesson.

Understanding of Alternative Conception

As defined in the data analysis matrix, understanding of the alternative conception is exhibited through the ability to discuss, apply, and write about the alternative conception. With the exception of Alexa, all of the participants (6) showed moderate to strong understanding of the alternative conception.

Tammy exhibited moderate understanding of the alternative conception. This was evident through her written and spoken definitions of teaching and learning following participation in the alternative lesson. Tammy described teaching as the process of giving students the tools necessary for learning a skill or solving a problem, while simultaneously letting them explore and discover the answers on their own (J4). She stated, the teacher should act as a guide and a resource for the students (J4). She described learning as discovering answers to questions and problems and applying this knowledge to situations in life (L3).
Acknowledgement of the Alternative Conception

As defined in the data analysis matrix, acknowledgement of the alternative conception is exhibited through interest and motivation toward applying the alternative conception, as well as recognition and acceptance of the alternative conception. All of the participants in the CCIU, except Alexa (6), exhibited moderate to strong acknowledgement of the alternative conception.

Joann showed strong acknowledgement of the viability of the alternative conception through her understanding, recognition, and ability to apply the alternative conception. Following her participation in the alternative lesson, Joann stated "Learning should be an active process with the 'learner' at the center of the action and as the individual around [which] all the activities, questioning and discoveries occur (J4)." In describing her final lesson, Joann stated that the teacher would introduce the problem, the students would then work in groups to create a "survival situation" (L5). After developing their ideas, the students would use Hollywood High software to create and act out a play (L5). The teacher's role would be to: introduce the problem and the software, then motivate and support students (L5). During the exit interview, Joann explained. "I came away [from this experience] with more knowledge than I had previously, [I now have more of an] open mind as far as to what I could possibly use technology for. Now I at least have ideas and will try to think of different ways to integrate [the computer] into the classroom (EI)."
Conclusion

In reference to the CCIU's ability to effectively create the conditions necessary for conceptual change to occur, the participants showed: moderate dissatisfaction with their preconceptions about teaching, learning, and classroom computer use (n=3), moderate to strong understanding of the alternative conception (n=6), and moderate to strong acknowledgement of the viability of the alternative conception (n=6). Based upon the analysis of each participant's progression through the conceptual change process and the collective case data analysis, it was determined that the instructional unit was moderately effective in creating the conditions necessary for conceptual change to occur. That is, the CCIU enabled most of the participants to experience each stage of conceptual change at moderate to strong levels.

As A Result Of Their Participation In The Instructional Unit, Did The Preservice Teachers Alter Their Conceptions About The Role Of The Computer In Teaching And Learning?

At the conclusion of the CCIU, the degree to which the participants altered their beliefs about teaching, learning, and classroom computer use varied. Three of the participants exhibited moderate conceptual change, and three exhibited weak conceptual change. (No conceptual change occurred with Todd). Moderate conceptual change (as defined in the data analysis matrix) is the overt demonstration of interest, motivation, understanding, and acceptance of the alternative conception, as well as a strong ability to apply the alternative conception to a classroom situation. Weak conceptual change is
defined in the data analysis matrix as the acceptance and understanding of the alternative conception, with a continued integration of and reliance upon initial beliefs about teaching and learning when applying the alternative conception in a classroom situation.

The participants exhibiting moderate conceptual change (Joann, Holly, and Alyssa) began the CCIU with behaviorist beliefs about teaching and learning, showed moderate to strong dissatisfaction with their preconceptions. In addition, these participants showed moderate to strong understanding of the alternative conception, and moderate to strong acknowledgement of the viability of the alternative conception.

The participants who exhibited weak or no conceptual change (Tammy, Maryann, Todd, and Alexa) began the CCIU with a range of preconceptions and varied levels of experience within the teacher preparation program. In addition, their levels of dissatisfaction with their preconceptions and understanding of the alternative conception varied, as did their acknowledgment of the viability of the alternative conception.

Tammy and Maryann began the CCIU near completion of the teacher preparation program and had formally studied constructivist theory and pedagogy prior to participating in this research study. Both, Tammy and Maryann, possessed holistic preconceptions about teaching, learning, and classroom computers use prior to participating in the CCIU. They also exhibited weak dissatisfaction with their preconceptions and showed moderate to strong acknowledgement of the viability of the alternative conception.

Prior to participating in the CCIU, Tammy and Maryann had already begun to assimilate constructivist ideas into their existing beliefs about teaching, learning, and
classroom computer use. This was evident as Maryann described behaviorist roles for the instructor and the learner in her final lesson. She stated that within her final lesson, the teacher's role was to "formally explain how a sentence is made and the components that go into making a sentence (L5)." The students' role in this class was to practice forming and writing sentences (L5). In her exit interview, Maryann showed that she acknowledged and expressed interest in constructivist uses of the computer in the classroom, but would continue to teach and integrate the computer into the classroom in behaviorist ways. "I probably will use [the computer] a little more, but I still think that the teacher is the main source of information and knowledge and the computer can help reinforce [that knowledge]...(EI)."

Todd and Alexa were at opposite ends of the spectrum in their preconceptions about teaching, learning, and classroom computer use and in their motivation toward what was being taught in the CCIU. Alexa began the instructional unit with behaviorist preconceptions, had weak dissatisfaction, expressed moderate understanding of the alternative conception, and weak to moderate acknowledgement of the viability of the alternative conception. Alexa was an average student who often seemed preoccupied. She exhibited little motivation toward the alternative conception and put little effort into completing the journal writings and unit assignments and exhibited weak conceptual change.

Todd expressed weak to no dissatisfaction with his preconceptions, strong understanding of the alternative conception, and strong acknowledgement of the viability of the alternative conception. Todd was a motivated and hard working student. Todd
espoused constructivist beliefs about teaching, learning, and classroom computer use before the CCIU began, thus he experienced weak to no dissatisfaction toward his initial conception. Todd's initial conceptions about teaching and learning were consistent with the alternative conception. The CCIU did appear to help Todd to reinforce and expand his existing constructivist beliefs.

The CCIU was designed to help preservice teachers who had behaviorist preconceptions about teaching, learning, and classroom computer use to alter their beliefs and adopt more constructivist ones. Of the seven preservice teachers participating in the CCIU, four began with behaviorist preconceptions. Three of the four preservice teachers who had behaviorist preconceptions (Joann, Holly, and Alyssa) began to alter or altered their beliefs about teaching, learning and classroom computer use.

Summary

The purpose of this chapter was to present the results of the collective case study about conceptual change-based technology instruction. As a result of participating in the CCIU, three of the four preservice teachers who possessed behaviorist preconceptions altered their existing conceptions about teaching, learning and classroom computer use. Tammy and Maryann, who possessed holistic preconceptions about teaching, learning and classroom computer use, built a stronger understanding and acceptance of the alternative conception, but had weak conceptual change as a result of participating in the CCIU. Todd, who began the CCIU with constructivist preconceptions about teaching, learning
and classroom computer use, exhibited no conceptual change; he already espoused constructivist beliefs that were consisted with those taught in the CCIU.

The analysis of the collective case showed that the CCIU was moderately effective in developing the conditions necessary for conceptual change to occur. That is, the CCIU enabled most of the participants to experience each stage of conceptual change at moderate to strong levels. In addition, most of the participants altered their conceptions of teaching, learning, and classroom computer use as a result of the CCIU.
CHAPTER VI. DISCUSSION AND RECOMMENDATIONS

If we plan to change teaching, learning and the way the computer is used in the K-12 classroom, there are many occurrences that need to take place; two of which are addressed within this research study. First, we must prepare our future teachers how to integrate the computer into the classroom effectively. Second, we must develop instructional strategies that help preservice teachers to build more constructivist beliefs and broaden their conceptions about teaching and learning and classroom computer use.

The purpose of this chapter is to discuss the results of the case study about preservice teacher technology preparation and conceptual change-based instruction. In addition, in this chapter recommendations for further development and implementation of conceptual change-based instructional strategies in preservice teacher preparation are presented. This chapter consists of four sections: background summary, discussion, recommendations, and conclusions.

Research Summary

Often, when preservice teachers enter teacher education courses, they possess beliefs about teaching and learning that are teacher-centered and behaviorist (Knowles & Holt-Reynolds, 1991; Tillema & Knol, 1997; Niederhauser, Salem & Fields, 1999). To help preservice teachers develop more comprehensive beliefs about teaching, learning, and classroom computer use, teacher educators must design instruction that directly confronts preservice teachers' existing beliefs (Knowles & Holt-Reynolds, 1991; Pintrich,
Marx & Boyle, 1993). Posner et al. (1982) argued that for students to change their existing beliefs and conceptions, they must progress through a cognitive process whereby they become dissatisfied with their existing conception and adopt an alternative conception that is understandable, believable, and applicable to related problems. Conceptual change-based teaching offers opportunities for preservice teachers to alter their beliefs about teaching and learning (Tillema & Knoll, 1997).

The purpose of this qualitative case study was to explore and examine the effects of a conceptual change-based instructional unit on preservice teachers' conceptions about the role of the computer in the classroom. The participants in this case study were eight preservice teachers who attended Iowa State University and completed the five-day, 10 hour Conceptual Change Instructional Unit (CCIU) during the 2000 summer semester. Data for this research study were collected throughout the CCIU through to use of six instruments: Preconception Identification Survey, the CCIU Preparatory Assignment, reflective journals, course interaction videotape, in-class/out-of-class assignments, and exit interview.

To understand the phenomenon of conceptual change within the context of preservice teacher technology preparation, two levels of data analysis were conducted: the eight individual cases and the collective case. The results of the individual case analyses indicated that four of the participants possessed behaviorist preconceptions about teaching, learning, and classroom computer use prior to participating in the CCIU. Three of the four participants who began the CCIU with behaviorist preconceptions about teaching, learning, and classroom computer use exhibited moderate to strong
dissatisfaction with their preconceptions. Two of the participants began the CCIU exhibiting holistic beliefs about teaching, learning, and classroom computer use and exhibited weak dissatisfaction with their preconceptions. One participant began the CCIU exhibiting constructivist beliefs about teaching, learning, and classroom computer use and did not become dissatisfied with his preconception. With regards to the intelligibility and plausibility stages of conceptual change, six of the seven participants exhibited moderate to strong understandings of the alternative conception and moderate to strong acknowledgement of the viability of the alternative conception.

The analysis of the collective case specifically addressed the two research questions of this study. This collective case analysis showed that the CCIU was moderately effective in developing the conditions necessary for conceptual change to occur. That is, the CCIU enabled most of the participants to experience each stage of conceptual change at moderate to strong levels.

In addition, the analysis of the collective case data showed that each participant progressed through the stages of conceptual change at their own rate based upon their existing conceptions and former experiences with education and pedagogy.

The CCIU was designed to help preservice teachers with behaviorist beliefs about teaching, learning, and classroom computer use to adopt more constructivist beliefs. The CCIU was moderately effective in helping the preservice teachers, who possessed behaviorist preconceptions, to alter their conceptions. For participants who began the CCIU with holistic or constructivist beliefs, the CCIU served to strengthen and broaden their existing conceptions and allowed them to further consider the viability of
constructivist pedagogy and its application in teaching, learning, and classroom uses of the computer.

Discussion

With the growing demand for new teachers and the increasing presence of computers in K-12 classrooms, teacher educators must develop instruction that effectively prepares preservice teachers to integrate computer technology into the learning process. Several researchers have investigated the conceptual change process in preservice teacher education (Niederhauser et al. 1999; Knowles & Holt-Reynolds, 1991; Dole & Sinatra, 1998; Tillema & Knol, 1997; Pintrich, Marx, & Boyle, 1993). In this research study, several conceptual change-based pedagogical strategies were incorporated into an instructional unit designed to help preservice teachers alter their behaviorist beliefs about teaching, learning, and classroom computer use and adopt more constructivist beliefs. In this section issues impacting the effectiveness of the CCIU are discussed.

Duration of the Conceptual Change Instructional Unit

The CCIU was conducted over a one-week period in which the participants met for instruction five consecutive days for two hours each day. Similar studies that implemented conceptual change-based instructional methods into a preservice teacher preparation course were conducted over entire semesters (Tillema & Knol, 1997; Niederhauser, Salem et al. 1999). Implementing conceptual change-based instructional strategies over a longer duration would allow preservice teachers to further develop at each stage of the conceptual change process. This extended time would also allow for
adaptation of the course content to better meet the specific learning needs of the preservice teachers.

The Conceptual Change Instructional Unit

The CCIU was deliberately designed to guide the preservice teachers through a cognitive process that motivated, directed, and empowered them to alter their conceptions about teaching, learning, and classroom computer use. Based on the stages of conceptual change, several instructional strategies were implemented in a specific sequence. These strategies, in sequence, were effective in helping three of the four preservice teachers with behaviorist preconceptions to adopt more constructivist conceptions (about teaching and learning). The CCIU integrated four specific instructional activities to facilitate conceptual change: reflective journals and class discussions, a model lesson, an alternative lesson, and a final lesson.

Reflective journals and class discussions were used to help the participants examine, articulate, explore, and share their preconceptions and experiences in the CCIU with their peers. As described by Knowles & Holt-Reynolds (1991), reflective journals provide a means for preservice teachers to reflect upon their previous and current educational experiences. Dole and Sinatra (1998) argued that students in a discussion are more motivated to consider and accept conflicting conceptions they have disregarded in the past because they value their peers' viewpoints.

Within the CCIU, the reflective journals and class discussions allowed the preservice teachers to comprehensively examine their existing conceptions, compare and
contrast those conceptions with the alternative conception taught, and develop stronger,
more complete understandings of the alternative conception. In addition, the reflective
journals and class discussions provided the instructor with a window into each preservice
teacher's thoughts about themselves and their thinking about teaching, learning, and
classroom computer use. This collection of text and verbal-based information allowed
the instructor to adapt the instruction to meet students' specific needs and facilitate
stronger conceptual change.

The model lesson activity was unique to the CCIU. This activity asked the
preservice teachers to design a model lesson on mathematics that incorporated the
computer. In the model lesson activity, the preservice teachers illustrated the layout of
their model classroom and described the roles of the teacher, students, and computer in the
mathematics lesson. In addition, they discussed their beliefs about teaching, learning, and
computer use and presented their lesson to their peers.

This activity helped the preservice teachers recognize and acknowledge their
preconceptions. Recognition of pre-existing beliefs is fundamental to significant
conceptual change (Tillema & Knol, 1997; Posner et al. 1982). Consistent with the work
of Pintrich et al. (1993) and Tillema and Knol (1997), the model lesson activity was
essential in helping the preservice teachers become aware of their existing conceptions.
Moreover, this activity set the stage for subsequent instruction to develop the preservice
teachers' dissatisfaction with their existing beliefs. The beliefs expressed in the model
lesson activity also served as a reference point for reflection, comparison, and conceptual
growth.
The alternative lesson was designed to be contradictory to the preservice teachers' model lessons. Because the preservice teachers participated as students in the constructivist-based alternative lesson, it was effective in demonstrating a different approach to teaching, learning, and classroom computer use. One participant stated that the alternative lesson was "outside of the box!" Pintrich et al. (1993) argued that as dissatisfaction grows learners behave much like scientists in that they begin to search out new intelligible, plausible, and more fruitful constructs that balance their understandings of the concept being learned.

The alternative lesson activity was effective, not only in demonstrating an alternative conception that was intelligible, plausible, and potentially fruitful, but it also allowed the preservice teachers to experience the alternative pedagogy in context rather than as an abstract theory. The alternative lesson also served as a pivotal point from which the preservice teachers could compare and contrast the differences between their pre-existing, behaviorist conceptions and the alternative, constructivist ones. Dole and Sinatra (1998) described the interaction between the learner and the concept being taught as engagement. Engagement is defined as the level to which the students develop strategies to connect and compare the alternative conception and their existing conceptions. The level of engagement experienced by the preservice teachers was critical in promoting dissatisfaction with their preconceptions and developing stronger understanding and acceptance of constructivist pedagogy.

In the final lesson, the preservice teachers were asked to apply the alternative conception they had learned. Dole and Sinatra (1998) argued that practice in applying the
alternative conception helps students to make the conception their own. Furthermore, applying the alternative conception allows students to discover its ability to be more useful than their preconception. This activity was effective in strengthening the preservice teachers’ understanding of the alternative conception and allowing them to experience the alternative conception. This lesson helped the preservice teachers to acknowledge how these new constructivist teaching strategies solve new problems that their behaviorist teaching strategies did not.

Finally, the CCIU was taught and implemented using constructivist pedagogical strategies. The CCIU was designed to help the preservice teachers to adopt constructivist beliefs about teaching, learning, and classroom computer use. These constructivist strategies were modeled throughout the CCIU. In addition, the instructional strategies used were externalized by the instructor so that the preservice teachers could understand why specific instructional choices and actions were taken. Pintrich et al. (1991) argued that because teacher educators are more experienced than preservice teachers with the principles of good instruction, they need to make the principles of good instruction explicitly available to their students.

**Types and Strength of Preservice Teacher Preconceptions**

The CCIU was specifically designed to address preservice teachers who held behaviorist preconceptions about teaching, learning, and classroom computer use. The preservice teachers in the CCIU espoused three different beliefs about teaching, learning, and classroom computer use prior to participating in the CCIU: behaviorist, holistic, and constructivist.
Although Niederhauser et al. (1999) and Tillema and Knol (1997) examined dissatisfaction with existing beliefs, they did not identify teacher education students' preconceptions. Because of the effects preconceptions have on learning (Posner et al. 1982), the CCIU attempted to identify and challenge preservice teachers preconceptions. It was assumed that preservice teachers in the CCIU had behaviorist preconceptions about teaching, learning, and classroom computer use (Sadera, 1997). The strength and type of preconceptions held by the preservice teachers effect the types of conceptual change-based instructional activities that will be most effective (Pintrich et al. 1993).

Levels of Involvement by Participants

The CCIU integrated instructional activities that asked the preservice teachers to be engaged in the instruction at varied levels. Dole and Sinatra (1998) argued that engagement in the learning process effects the extent of conceptual change by the learner. Dole and Sinatra (1998) suggested that the processing of information is based on a continuum ranging from low engagement to high engagement. High engagement is based upon participation in effortful analytical processing of information (e.g., designing and teaching and instructional lesson), while low engagement is based more upon passive and superficial information processing (e.g., reading about an instructional process in a textbook). Within the CCIU, low engagement activities such as the reading assignment were less effective at helping the preservice teachers to cognitively process the conception being taught than were the high engagement instructional activities such as the model, alternative and final lessons.
Recommendations

Students studying to be teachers enter their preservice teacher preparation programs with preconceptions about teaching, learning, and classroom computer use that tend to be behavioristic and teacher-centered in nature (Sadera, 1997). If teacher educators are to help preservice teachers build more comprehensive beliefs about teaching, learning, and classroom computer use, it is necessary to implement instruction that explicitly confronts preservice teachers' preconceptions. The purpose of this section is to offer recommendations for future research on conceptual change-based instruction for preservice teacher technology preparation.

The CCIU was implemented over a one-week period. The CCIU was intensive and may not have allowed the preservice teachers time to fully develop a comprehensive understanding of constructivist pedagogy. Perhaps, partly because of the duration of the CCIU, not all of the preservice teachers who possessed behaviorist preconceptions about teaching, learning, and classroom computer use fully altered their beliefs. More research needs to be conducted that addresses how time, both the duration of the instruction and the time spent between instructional meetings, effects the preservice teachers ability to completely alter their conceptions about teaching, learning, and classroom computer use.

The CCIU integrated several conceptual change-based instructional strategies. Although these strategies were effective within this instructional environment, other conceptual change-based strategies must be designed and researched so that the most effective teaching methods can be implemented into and throughout preservice teacher technology preparation programs. In addition, the development and integration of
engaging activities, that allow preservice teachers to cognitively process the epistemologies driving constructivist pedagogy, must be examined. Finally, the CCIU was designed to address behaviorist preconceptions held preservice teachers. The preservice teachers participating in the CCIU held preconceptions ranging from behaviorist to constructivist with various strengths. As a result, the effectiveness of the conceptual change strategies implemented varied. Additional research must be done that examines the range and strength of preconceptions preservice teachers possess upon entering teacher education classes. A better understanding of preservice teacher preconceptions can inform the design of conceptual change-based instruction that addresses the various preconceptions.

Conclusion

If preservice teachers continue to enter teacher preparation programs with behaviorist beliefs about teaching, learning and classroom computer use, teacher educators must continue to research and develop instructional strategies that address and confront those preconceptions. Confronting preservice teachers preconceptions will help them to develop stronger, broader, and more comprehensive beliefs about teaching, learning and classroom computer use. The CCIU was moderately effective in developing the conditions necessary for conceptual change to occur with the participants. Continued case study research and experimentation with conceptual change-based teaching and preservice teacher technology preparation is necessary to fully realize the potential of this cognitive process.
This research is important in that it addressed and confronted preservice teachers’ existing preconceptions and helped them to alter and develop more expansive and comprehensive conceptions about teaching, learning, and classroom computer use. This research addressed various aspects of preservice teacher technology preparation and specifically provides insight to designing instruction beyond using technology in teaching but technology’s effects on how we think about teaching and pedagogy. Because preservice teachers begin teacher preparation programs with strongly held preconceptions about teaching, learning, and classroom computer use, teacher educators must continue to develop instructional strategies that give preservice teachers new experiences as students. These new learning experiences must be structured to optimize the chances that they will embrace constructivist principles and effectively integrate these principles in future practice, when they become teachers.
REFERENCES


Carroll, T. G. (2000). If we didn't have the schools we have today, would we create the schools we have today? Contemporary Issues in Technology and Teacher Education, 1(1), on-line: www.citejournal.org


*Computers in Human Behavior, 5*(1), 37-45.


APPENDIX A. DOCUMENTATION OF HUMAN SUBJECTS APPROVAL
Last name of Principal Investigator: Sadera

Checklist for Attachments and Time Schedule

The following are attached (please check):

12. X Letter or written statement to subjects indicating clearly:
   a) the purpose of the research
   b) the use of any identifier codes (names, −s), how they will be used, and when they will be removed (see item 17)
   c) an estimate of time needed for participation in the research
   d) if applicable, the location of the research activity
   e) how you will ensure confidentiality
   f) in a longitudinal study, when and how you will contact subjects later
   g) that participation is voluntary; nonparticipation will not affect evaluations of the subject

13. ___ Signed consent form (if applicable)

14. ___ Letter of approval for research from cooperating organizations or institutions (if applicable)

15. ☑ Data-gathering instruments

16. Anticipated dates for contact with subjects:
   First contact: May 15, 2000
   Last contact: May 30, 2000

17. If applicable: anticipated date that identifiers will be removed from completed survey instruments and/or audio or visual tapes will be erased:
   August 5, 2001

18. Signature of Departmental Executive Officer: D. Cooper
   Date: 7-21-2000
   Department or Administrative Unit: ___

19. Decision of the University Human Subjects Review Committee:
   ☑ Project approved   ☐ Project not approved   ☐ No action required

Name of Human Subjects in Research Committee Chair: Patricia M. Keith
   Date: 5-1-00
   Signature of Committee Chair: __________
APPENDIX B. PARTICIPANT CONSENT FORM AND COVER LETTER
Preparing preservice teachers to use computers effectively in teaching and learning is paramount for the Iowa State University College of Education. It is important for educators to create teaching strategies that help preservice teachers to develop more comprehensive conceptions about classroom computer use. The purpose of this study is to measure the effectiveness of conceptual change teaching strategies for preservice teacher technology preparation.

Data for this research study will be collected through videotapes of classroom activities, interviews, and written journal entries. The data analysis for this study is designed to measure the ability of specific instructional activities to help you develop more comprehensive conceptions about classroom computer use.

Your participation in this research study is voluntary, but critical to this study. Data collected through this research will have a significant contribution to the preparation of future teachers and their use of technology in teaching and learning. It is important that your participation in this study is honest and candid. Your involvement in this study will consist of approximately seven to nine hours of participation in classroom instructional activities and ten to fifteen minutes of exit interviews.

Be assured that all data collected in this study will be handled with strict confidence. No individual participants will be identified in any reports. The contributions you make during your participation in the research study will in no way affect your class grade or status within the College of Education. All video taped and written data will be destroyed immediately following data analysis.

We thank you for your time and willingness to participate and will be glad to furnish you with additional information and results of this study if you are interested.

Please sign here noting you have read this document: ___________________________ Date: __________

Respectfully,

William A. Sadaqa
Principal Investigator
515-294-6280
APPENDIX C. CONCEPTUAL CHANGE INSTRUCTIONAL UNIT LESSON PLANS (ORIGINAL)
Conceptual Change Instructional Unit

The following section describes how each lesson and activity should be integrated into the classroom. This section consists of five lessons for the unit.

**Reflective Journal Pre-Assignment**

Prior to and following participation in the CCIU, the participants were asked to complete an assignment. The assignment asked each student to describe his or her personal definition of the terms teaching, learning, and classroom computer integration. That is, subjects were to answer these three questions: Imagine yourself filling out an application for acceptance into the College of Education, you are asked to define the meaning of teaching, learning, and classroom computer integration.

**Lesson 1**

**Objectives**

As a result of this lesson the students will be able to:

- Identify their existing conceptions about classroom computer use.
- Identify their beliefs about learning and teaching.
- Discuss their beliefs about classroom computer use.
- Realize their beliefs about how students learn.

**Materials**

For each group of two students:

- Laminated piece of large paper
- Tape
- Small laminated paper desks, computers, teacher, students, etc.
Activity

Present the following situation to the students and ask them to brainstorm with their partners, answers to the following questions. In addition, ask students to use the laminated characters and tape to create a graphical description of the classroom layout (e.g., What is the teacher doing? What are the students doing? What does the computers do?). In addition, the answers to these questions will be written on pieces of construction paper and posted throughout the class for reflection later in the unit.

Situation

Miss Smith’s 3rd grade math class is starting a unit on multiplication and division.

Questions

- Describe a lesson in which the computer is integrated to help the students learn multiplication. In your description include information about what the teacher does, what the students do, how the computer is used, and exactly what is happening. Be as specific as possible.
- Describe your goals and expectations for the students as a result of this lesson.
- Describe how the classroom is organized.
- Describe where the computers are.
- Describe your reasoning behind why you are incorporating the computer in this manner in respect to student learning and goal attainment.

After answering the questions, the students gathered as a class and discussed their answers while the instructor posted the students’ classroom activity and layout ideas onto
the board. The instructor should look to get a full understanding of the students' beliefs about what the classroom looks like and how the activity is organized. Most importantly, the instructor should lead students to acknowledging their existing beliefs about teaching and learning through the activities and classrooms they designed.

**Reflective Journal Assignment**

During class the preservice teachers will share their beliefs about teaching, learning, and classroom computer use with a partner. One student will describe to the other in the group what teaching is, what learning is and the role of the computer in the scenario they designed earlier. This will be signed and placed into their journal.

**Lesson 2**

**Objectives**

As a result of this lesson the students will be able to:

- Compare and contrast differences between their existing conception and the alternative conceptions presented by the instructor.
- Compare and contrast differences in the definitions of teaching, learning between their existing beliefs and the alternative conception presented by the instructor.
- Recognize differences between their existing beliefs about classroom computer use and the alternative beliefs being presenting by the instructor.

**Materials**

- A sample of laminated, student created classroom design from last lesson.
• A sample laminated classroom design describing the organization of the alternative conception.

• Copies of reading assignment for next lesson

Activity

During this lesson, present the students the following scenario as an alternative to what the students described in the previous lesson:

What if, as an introduction to multiplication and division, Miss Smith allowed her students to sit at the computers in groups of two, without previously speaking about multiplication and division, and play with a piece of mathematic software? (Be sure to create a laminated classroom similar to what the students created in the previous lesson.) The goals for this lesson were for the students to gather information and build ideas and theories about the concepts of multiplication and division.

In this classroom the computers are scattered throughout the room in five pods of three or four computers each. The software the students are working with allows the students to place different numbers of items on the screen then multiply or divide them to see the results. For example, on one side of the screen, the student places three apples, on the other side, the student places five apples, then asks the computer to multiply the two. The computer returns a result of fifteen apples. The students could also ask the computer to divide the two groups of apples and return a result. Throughout their experimenting the students are discussing
between each other and taking notes on a chart looking for common threads and possible reasons or solutions to what they are seeing.

To facilitate the success of the activity and make sure the students are on task, the teacher walks from one group of students to another asking leading questions, and helping the students with any problems they might be having. For example as the instructor approaches one of the groups she notices that the two students are having trouble finding common threads. She asks them to try experimenting by only changing one of the numbers in the equation (e.g., 1x1=, 1x2=, 1x3=). “What is happening?” She asks the students. “What if you try using zero instead of one? What if you try using the number two? What’s the difference? What is similar?” These questions help to offer the students some answers and lead the students toward a better understanding of themes that can be found and methods to go about finding them. Most importantly it gives the students an opportunity to ask higher-level questions of each other. After a few minutes, Miss Smith returns to the same group to make sure they are progressing.

Lastly, the students will join together as a class and discuss their results. Each group of students would present one of their conclusions until they’ve noted all of the class findings. During this discussion, the instructor will again ask leading questions, such as: “How did you discover that? Did anyone find a similar theme, but in a different situation? What does the theme mean and how might we use it in the future?” In addition to the leading questions, the instructor will look for more advanced understanding of the concepts being taught.
After presenting this alternative approach to integrating the computer into the classroom, the class should discuss the differences between approaches and epistemologies driving the students’ (behaviorist) examples and the instructors’ (constructivist) example. Moreover, the instructor should ask the following questions during the discussion: “What is the teacher doing? What are the students doing? What does the computer do?”

**Reflective Journal Assignment**

*(In-Class) Ask students to write answer the following questions in their journal:*

In this alternative scenario, is the teacher teaching? Why or why not? Is this learning? Why or why not?

*(Out-of-Class) Ask students to create a list of common characteristics and themes of teaching and learning across the three reading assignments. In addition, for each of the reading assignments describe what the teacher is doing, what the student is doing, and what is the computer doing.*

**Lesson 3**

**Objectives**

As a result of this lesson the students will be able to:

- Describe characteristics across behaviorist and constructivist learning situations.
- Compare and contrast differences in the role of the computer between the students’ scenarios, the instructor’s scenarios and the readings.
Materials

- Readings from text

Activity

Prior to this lesson the students were asked to read several articles about classroom computer use and related constructivist teaching and learning strategies. During the class, students and teacher discuss the main themes from the readings, and reflect on prior activities and how they relate to the readings. During the discussion, ideas, themes, and points of agreement or disagreement should be mapped out on the board for a visible account of the discussion. The discussion should lead toward a common understanding of teaching and learning based on previous lessons and activities. In addition, the discussion should cover what the role of the computer is in the scenario described by the instructor and the readings.

Reflective Journal Assignment

(In-Class) Based on the common themes and characteristics of teaching and learning drawn from the readings and classroom activities, is this an accurate definition of teaching and learning?

Lesson 4

Objectives

As a result of this lesson the students will be able to:

- Retrieve and draw from their growing knowledge base about classroom teaching to solve instructional situations more effectively.
- Integrate constructivist strategies to solve classroom problems.
• Apply constructivist approaches to integrate computers into classroom situations.

• Connect ideas between existing beliefs about classroom teaching and computer integration and the new beliefs being presenting by the instructor.

Activity

During this lesson, the instructor presented several software packages that fit well within a constructivist framework. After presenting the software, the students are given time to experiment with the programs and build an understanding of what the software is capable of. Students in groups then choose three pieces of software and create an instructional lesson that integrates the software. Students should be asked to answer the following questions while designing their lesson: what does the teacher do? What does the computer do? What is the student doing with the computer?

Follow this activity with a discussion of the students' examples of classroom computer integration. Focus the discussion on their reasoning behind why the solved the situation how they did. Lead toward an acknowledgement of how the alternative conception solves the situation better then their old conception.

Reflective Journal Assignment

Students are to choose one of the three lessons they developed in class and compare and contrast what the teacher does, what the students do and how the computer is being used versus the initial classroom model they developed in the first lesson. Time depending, this may be done in-class or out-of-class.
Lesson 5

Objectives

As a result of this lesson the students will be able to:

• Discuss differences between behaviorist teaching strategies (initial conceptions) and constructivist teaching strategies (alternative conception) and classroom computer integration.

• Design instructional situations in which computers can be used to more effectively help students learn.

• Adapt classroom situations for students to develop stronger understandings of the concepts being taught.

Activity

During the final lesson, in small groups, the class will discuss and review the lessons they created in the previous class. The class will then join together and discuss the latest entry in their reflective journal. During the discussion the instructor challenged the scenarios developed by the students. In addition, the students were given the opportunity to challenge the alternative approach and articulate their newly constructed knowledge. This activity allows for both evaluation of student understanding and measurement of the level of conceptual change within each student. Finally, the class will review (if necessary) and conclude.

Reflective Journal Post-Assignment

Following participation in the CCIU, the participants were asked to complete an assignment. The assignment asked each student to describe his or her personal definition
of the terms teaching, learning, and classroom computer integration. That is, subjects
were to answer these three questions: Imagine yourself filling out an application for
acceptance into the College of Education, you are asked to define the meaning of
teaching, learning, and classroom computer integration.
APPENDIX D. CONCEPTUAL CHANGE INSTRUCTIONAL UNIT

(CHANGES)
This section describes the changes that were made, both in the activities of the instructional unit and the journal assignments accompanying the unit. These changes were influenced by the pilot study, expert recommendations, and the class' progression through the unit of instruction.

**Day one.** At the opening of the first class, the participants completed the consent form, the PIS, and the preparatory assignment. Following completion of the instruments, the students joined with a partner to create their model lesson.

**Day two.** During the second-class meeting, the participants presented their model lesson to the group and discussed the role of the teacher, the learner, and the classroom computer within those models. Following this activity the participants paired with a different student and described what teaching was, what learning was, and what the role of the computer was based on the model lesson they designed with their other partner. These descriptions were recorded into the participant's journal. Following this activity, the instructor conducted the alternative lesson with the participants. Finally, the participants were assigned several readings that discussed the theories behind constructivism and several examples of constructivist-based lessons. As a take-home assignment, the participants were asked to describe, in their journals, the similarities and common themes they found within each of the example lessons in the readings.

**Day three.** During the third class meeting, the participants discussed the alternative lesson and described the role of the teacher, the role of the learner, and the role of the computer. This information was originally going to be told to the participants and then discussed; instead the instructor chose to have the participants describe the
characteristics of the lesson based on their experiences when participating in the lesson. Following this discussion, the participants were asked to compare and contrast the differences between their model lesson and the alternative lesson in their journal. The students were then asked to complete journal assignment 4 at home. In addition, Journal question was modified from asking the participants to note whether the alternative characteristics of teaching and learning were acceptable as new definitions to asking the participants to create new definitions of teaching and learning, based on the past classroom readings and activities. This change was made because (in-class) journal 3 and journal 4 had been assigned very close together and the instructor felt the original journal question 4 would be redundant when assigned so close to journal question 3.

Day four. During the fourth class, the students were introduced to six pieces of software, given some time to work with them and asked to design a lesson that integrates one of the pieces of software. The six pieces of software were: Imagination Express: Rainforest, The Hot Dog Stand, The Factory, Hollywood High, Harry and the Haunted House, and Stanley's Sticker Factory.

Day five. In the final lesson, each participant presented the lesson they designed the day before to the rest of the class. Each lesson was discussed and the students were asked to complete their final journal assignment that asked them to compare and contrast the differences between their original model lesson the lesson they designed in the previous class. The following Monday and Tuesday each participant attended an exit interview.
APPENDIX E. PRECONCEPTION IDENTIFICATION SURVEY
The purpose of this survey is to gather information about preservice teachers' perceptions and beliefs about computers in education. There are six sections in this survey: background, experience with computers in education, attitudes about computers in education, computer proficiency, attitudes about reality, and perceptions of the role of computers in the classroom.

Your participation in this survey is voluntary. All of your responses on this survey will be kept strictly confidential. Only group data will be reported; no individual respondent will be identified in any reports. The survey will take approximately 15 minutes to complete. Thank you for participating in this survey.

To separate your survey from your classmates, please provide the last four digits of your social security number and your birth date.

__ __ __ __ - ___ / ___ / ___

Section I: Background Information
The purpose of this section is to gather information about you and your career plans. Please answer each question or statement by choosing the answer that most appropriately describes you. If there is a blank, please write the answer on the line provided.

1. What year are you in college?
   a. first year
   b. sophomore
   c. junior
   d. senior
   e. fifth year senior

2. What is your gender?
   a. female
   b. male

3. What area of education are you studying?
   a. El Ed
   b. Sec Ed
   c. ECE
   d. Ag Ed
   e. Sp Ed
   f. Itech
   g. FCS
4. Do you plan to earn the Educational Computing Minor?
   a. yes
   b. no

5. What are your plans the first year after graduation from college?
   a. go to graduate school
   b. teach in K-12 education
   c. work in the business sector
   d. join the military
   e. hold a position in education other than teacher

6. What type of student do you consider yourself to be?
   a. "A" student
   b. "B" student
   c. "C" student
   d. "D" student
   e. other

7. Before enrolling in CI 201, have you had formal instruction on how to use a computer?
   a. yes (i.e., high school course, college workshop, university course)
   b. no, self-taught
   c. no, taught by a friend or other
   b. no, no instruction at all

8. How often do you use a computer (for any reason)?
   a. more than once a day
   b. usually once a day
   c. usually 2-4 times a week
   d. once or twice a month
   e. never

9. For what purposes do you regularly use a computer (mark all that apply)?
   a. to communicate with others via email
   b. to complete homework (i.e. word processor)
   c. for entertainment (games)
   d. to find information (i.e. internet)
   e. to write computer programs

10. Do you own a computer?
    a. yes
    b. no
11. Did you have a computer at home when you were growing up?
   a. yes
   b. no

Section II: Experience with the computer in education
The purpose of this section is to gather information about your experiences with computers in education. For this section, computer-related technology refers to constantly evolving forms of computers, peripherals and supporting software used to enhance learning. For each item, choose the answer that most appropriately describes your experiences. If there is a blank, please write the answer on the line provided.

12. In your K-12 schooling, did any of your instructors in non-computer-related courses use computer-related technology?
   a. yes
   b. no (go to section III)

13. If yes, in how many non-computer courses were computer-related technologies used by the instructor?
   a. one
   b. two
   c. three
   d. four or more

Questions 14-19
Using a scale where
a = never used,
b = occasionally used (once or twice a term),
c = sometimes used (once a month),
d = regularly used (once a week or more),
indicate the level to which your personal experience is consistent with each statement.
a = never, b = occasionally, c = often, d = regularly

In your undergraduate courses, how often were computer-related technologies used:
14. for teacher-delivered presentations.   a b c d
15. for student-delivered presentations.   a b c d
Section III: Attitudes about computers in education

The purpose of this section is to gather information about your attitudes toward computers in education. Using a scale where a = I don't know, b = strongly disagree, c = disagree, d = agree, e = strongly agree, indicate the level to which your attitudes are consistent with each statement.

<table>
<thead>
<tr>
<th>Statement</th>
<th>Scale</th>
</tr>
</thead>
<tbody>
<tr>
<td>20. The primary reason for using computers in the classroom is to develop students' keyboarding skills.</td>
<td>a b c d e</td>
</tr>
<tr>
<td>21. Computer-related technologies are an important part of the future for improving the quality of education.</td>
<td>a b c d e</td>
</tr>
<tr>
<td>22. Computer-related technologies should be used to improve learning throughout the curriculum.</td>
<td>a b c d e</td>
</tr>
<tr>
<td>23. Computer-related technologies are unnecessary luxuries in school settings.</td>
<td>a b c d e</td>
</tr>
<tr>
<td>24. Computer-related technologies are of little value in education because they can be used to teach only one or two subjects.</td>
<td>a b c d e</td>
</tr>
<tr>
<td>25. Computers should be used, mainly, to supplement the curriculum.</td>
<td>a b c d e</td>
</tr>
<tr>
<td>26. Computers will soon replace the teacher.</td>
<td>a b c d e</td>
</tr>
<tr>
<td>27. Overall, I think the computer is a very important tool for instruction.</td>
<td>a b c d e</td>
</tr>
</tbody>
</table>
28. Computer-related technologies are of little use in the classroom because they are too difficult to use. a b c d e

29. Computers are useful when teaching thinking and problem solving skills. a b c d e

30. Children should be taught how to use computers so they will know how to use them when they enter the business world. a b c d e

31. The computer gives better feedback to a student than a teacher does. a b c d e

32. Without the use of the computer, students often obtain knowledge they never use. a b c d e

33. It is more important for students to practice their handwriting skills, when learning to write stories, than to use a word processor. a b c d e

34. The computer is more effective than a teacher in providing individual feedback. a b c d e

35. Computers can give a student a better basic understanding of a topic than a lecture can. a b c d e

36. A computer simulation program can help a student understand a new concept better than a teacher. a b c d e

37. Anything that can be done in education with a computer can be done just as easily without one. a b c d e

38. Computers should not be used in the classroom. a b c d e

39. Computers should be used by students who complete their school work early. a b c d e

40. Computers should be used primarily to help "slow" students keep up with the rest of the class. a b c d e
### Section IV: Computer Proficiency

The purpose of this section is to gather information about your skill and level of proficiency in using various computer applications. Indicate your level of proficiency with each item using a scale where:

- **a** = Unfamiliar - I do not know what this item is;
- **b** = None - I have no proficiency. I know what this item is, but I don’t know how to use it;
- **c** = Low - I have little proficiency with this item, and I could use instruction;
- **d** = Medium - I have some proficiency with this item, but I could use some advanced instruction;
- **e** = High - I have very high proficiency with this item.

**Computer Tool Software**

<table>
<thead>
<tr>
<th>Item</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
</tr>
</thead>
<tbody>
<tr>
<td>41. Word Processing</td>
<td></td>
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<td></td>
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<tr>
<td>42. Database</td>
<td></td>
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<tr>
<td>43. Spreadsheets</td>
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<tr>
<td>44. Desktop Publishing</td>
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<td></td>
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<tr>
<td>45. Graphics/Drawing programs</td>
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<tr>
<td>46. Presentation software (e.g. Power Point)</td>
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<tr>
<td>47. Hypermedia/ Interactive Multimedia (e.g. Hypercard, Hyperstudio, Linkway)</td>
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</tbody>
</table>

**Other**

<table>
<thead>
<tr>
<th>Item</th>
<th>a</th>
<th>b</th>
<th>c</th>
<th>d</th>
<th>e</th>
</tr>
</thead>
<tbody>
<tr>
<td>48. e-mail</td>
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<tr>
<td>49. internet (e.g. WWW)</td>
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<tr>
<td>50. File Transfer Protocol (FTP)</td>
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</tbody>
</table>
Section V: Attitudes About Reality

The following 28 items represent statements about the way the world works. You will probably find that you agree with some of the statements and disagree with others to varying extents. Please indicate your reaction to each statement according to the following scale:

- a = Strongly disagree with this statement;
- b = Moderately disagree with this statement;
- c = Slightly disagree with this statement;
- d = Exactly neutral with this statement;
- e = Strongly agree with this statement;
- f = Moderately agree with this statement;
- g = Slightly agree with this statement.

54. Who has power is a central issue in understanding how society works. a b c d e f g

55. It is maladaptive to refuse to conform to the demands of society. a b c d e f g

56. If one works hard at solving a problem, one can usually find the answer. a b c d e f g

57. If everyone learns what is important to him or her, the world would take care of itself. a b c d e f g

58. Most sex differences have an evolutionary purpose. a b c d e f g

59. People who achieve success usually deserve it. a b c d e f g

60. The saying "You shall know the truth and the truth shall make you free" is still valid today. a b c d e f g
|   |   |   |   |   |   |   |   |   |
|---|---|---|---|---|---|---|---|
| 61. | The more technology we develop, the better our science will be. | a | b | c | d | e | f | g |
| 62. | Accidental solutions to problems are very rare. | a | b | c | d | e | f | g |
| 63. | At the present time, people are recognized for their achievements regardless of their race, sex, or social class. | a | b | c | d | e | f | g |
| 64. | People cannot be trained to be creative - they are either born that way or not. | a | b | c | d | e | f | g |
| 65. | People who demand social change are usually those who have been ineffectual in present society. | a | b | c | d | e | f | g |
| 66. | The United States has the most egalitarian society in the world. | a | b | c | d | e | f | g |
| 67. | Once a scientific fact is discovered it remains part of science from then on. | a | b | c | d | e | f | g |
| 68. | We communicate much more information to each other than we are aware of doing. | a | b | c | d | e | f | g |
| 69. | Personality characteristics account for most differences in human behavior. | a | b | c | d | e | f | g |
| 70. | Important ideas are most likely to originate from prestigious institutions. | a | b | c | d | e | f | g |
| 71. | It is more important to be liked than to be powerful. | a | b | c | d | e | f | g |
| 72. | Biological sex, sex role, and sexual preference are highly related to each other in normal people. | a | b | c | d | e | f | g |
| 73. | The mother-infant relationship is a key to understanding adult behavior. | a | b | c | d | e | f | g |
74. People who are part of minority groups who are less successful should not have to worry about other people in these groups.  

75. Society must protect itself from those who do not accept its rules.  

76. Most people would cooperate with each other if only they understood that everyone would benefit by such actions.  

77. Scientific merit is determined by the excellence of the work done.  

78. Those who are nonconformists during one period of history are often found to be innovators by future eras.  

79. It is better not to know too much about things that cannot be changed.  

80. Physiological differences limit the degree to which males and females can learn to be similar to each other.  

81. Most social problems are solved by a few very qualified individuals.
APPENDIX F. PRECONCEPTION IDENTIFICATION SURVEY RESULTS
Participant's Descriptive Data

Part one of the PIS was used to collect participants' descriptive data. Of the eight preservice teachers participating in the CCIU, six (6) were female and two (2) were male. The participants ranged from first year to more than five years of experience in college. Four (4) of the participants were freshman or sophomores, one (1) was a junior, one (1) was a senior and two (1) was a fifth year, and one (1) was a graduate student. Seven of the respondents (7) indicated they were secondary education students. Moreover those seven participants (7) also indicated that, after graduation, they plan to teach at the K-12 level.

Data was also collected about the participants' formal computer experience. The data indicated that six (6) of the participants had had formal computer instruction either through a high school course, a college workshop or a university course; and two (2) had no formal instruction prior to participating in this research study. In addition the participants were asked to indicate how frequently they used computers and for what purpose. Six (6) of the eight participants noted that they use computers more than once a day, one (1) participant noted that they use a computer usually once a day, and one (1) participant indicated that they use a computer once or twice a month. Six (6) students indicated they use the computer to communicate with others via e-mail, all eight (8) of the participants indicated they use the computer to do homework (i.e., word processor), four (4) of the participants indicated they use the computer for entertainment (i.e., computer games), and five (5) of the participants indicated that they use the computer to find information (i.e., access the internet). None (0) of the participants indicated that they use
the computer for computer programming or to write computer programs. The participants were also asked to indicate whether they had a computer in their home while they were growing up and if they currently own a computer. Four (4) of the participants indicated that they had had a computer in their home growing up and all eight (8) of the participants indicated that they currently own a computer.

Experience With Computers in K-12 Classroom

Section two of the PIS was used to collect data about the preservice teachers' experience with computers in the K-12 classroom. Four (4) of the eight participants indicated that computers and computer related technologies were used by their teachers in their K-12 schooling. Of the participants who indicated that their K-12 teachers used computers, two (2) participants indicated that the computer was used by the teacher for presentations occasionally and one (1) indicated that the computer was used for teacher presentations regularly. Two (2) participants indicated that the computer was used occasionally for student presentations. Four (4) of the participants indicated that the computer was used for student activities either often or occasionally. Three (3) of the participants noted that teachers never used the computer for electronic communication. Three (3) participants indicated that computers were often used to create student products. Lastly, two (2) participants indicated that teachers often used computers to access information and two (2) participants indicated that teachers occasionally used computers to access information.
Attitudes About Computers in Education

Section three of the PIS was designed to gather data about the participants' attitudes toward computers in education (i.e., Computer related technologies are an important part of the future for improving the quality of education; Computers are useful when teaching thinking and problem solving skills). For each statement in this section, the participants were asked to indicate to what degree they disagree or agree with the twenty statements about the role of the computer in the classroom. Responses in this section were based on a five point Likert scale ranging from I don't know (1) to strongly agree (5). Overall the participants had eclectic attitudes toward computers in education with a mean score of 3.26.

Computer Proficiency

Section four of the PIS asked the participants to indicate their computer proficiency based on two categories: tool software (i.e., word processing, database software, desktop publishing software, etc.) and other (i.e., web page development software, internet browser software, e-mail software, etc.). The participants rated their proficiency using the following five point Likert scale: unfamiliar (1), no proficiency (2), low proficiency (3), medium proficiency (4), high proficiency (5). Overall the participants rated themselves moderately proficient with tool software with a mean of (3.05). They rated themselves less proficient within the other software category (2.87) (Table 4).
Attitudes About Reality

Data from the 28-item Attitudes About Reality Scale (AAR) were used to examine the participants' epistemological beliefs. This instrument, developed by Unger (1986), was based on a seven point Likert scale ranging from strongly disagree (1) to strongly agree (7). The participants mean scores ranged from 3.57 to 5.04 with an overall mean of 4.11. Studies using the AAR in the past (Hannafin & Freeman, 1995; Sadera, 1997) found that many preservice teachers' scores fell in the middle of the scale (4) and could not be categorized as strictly behaviorist or constructivist, but as eclectic. Earlier research studies using this instrument separated the

<table>
<thead>
<tr>
<th>Computer-Related Technology</th>
<th>n</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Computer Tool Software</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Word Processing</td>
<td>8</td>
<td>4.38</td>
</tr>
<tr>
<td>Database</td>
<td>8</td>
<td>3.25</td>
</tr>
<tr>
<td>Spreadsheets</td>
<td>8</td>
<td>3.63</td>
</tr>
<tr>
<td>Desktop Publishing</td>
<td>8</td>
<td>2.88</td>
</tr>
<tr>
<td>Graphics/Drawing programs</td>
<td>8</td>
<td>2.88</td>
</tr>
<tr>
<td>Presentation software (i.e., Power Point)</td>
<td>8</td>
<td>2.88</td>
</tr>
<tr>
<td>Hypermedia/Interactive Multimedia</td>
<td>8</td>
<td>1.50</td>
</tr>
<tr>
<td>Other</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E-mail</td>
<td>8</td>
<td>4.25</td>
</tr>
<tr>
<td>Internet</td>
<td>8</td>
<td>4.38</td>
</tr>
<tr>
<td>File Transfer Protocol (FTP)</td>
<td>8</td>
<td>2.00</td>
</tr>
<tr>
<td>Distance Education/Conferencing</td>
<td>8</td>
<td>1.88</td>
</tr>
<tr>
<td>Programming (e.g., Logo, C++, Basic)</td>
<td>8</td>
<td>1.88</td>
</tr>
<tr>
<td>Web Page Development</td>
<td>8</td>
<td>2.88</td>
</tr>
<tr>
<td>Computer Proficiency Overall</td>
<td></td>
<td>2.97</td>
</tr>
</tbody>
</table>

Scale: 1=I don't know  
2=no proficiency  
3=low proficiency  
4=medium proficiency  
5=high proficiency
samples into three groups: eclectic behaviorist, eclectic, and eclectic constructivist (Hannafin & Freeman, 1995; Sadera, 1997). The eclectic behaviorist group consisted of scores ranging from 2.78 to 3.5; the eclectic group had scores ranging from 3.53 to 4.00; the eclectic constructivist group had scores ranging from 4.01 to 5.00. Within this research study the participants rated their epistemological beliefs as eclectic (n=4) and eclectic constructivist (4). None of the participants had scores that fell within the eclectic behaviorist range.

Impact of Computer Use on Learning

Section six of the PIS was used to collect data about preservice teachers' preconceptions of the impact of computer use on learning. This section contained twenty-five items (five items based on each of the five categories of the Tomas and Boysen Taxonomy, 1984). Within this section, the participants were asked to indicate whether or not they considered each statement to be an effective use of the classroom computer to impact student learning. If the participants agreed that this use of the computer would impact student learning, they were then asked to indicate to what degree they felt learning would be impacted using the following scale: (1) slightly impacted, (2) moderately impacted, (3) strongly impacted.

To measure which category of the Thomas and Boysen Taxonomy (1984) was most representative of the preservice teachers' beliefs about classroom computer use, mean scores were generated for the five items of each category. The data revealed that the
category with the highest mean was reinforcing (2.33). Table 5 lists the mean scores of the items for each of the Thomas and Boysen Taxonomy (1984) categories.

Table 5. Means Scores for Thomas and Boysen Taxonomy Categories

<table>
<thead>
<tr>
<th>Category</th>
<th>n</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experiencing</td>
<td>8</td>
<td>1.65</td>
</tr>
<tr>
<td>Informing</td>
<td>8</td>
<td>1.33</td>
</tr>
<tr>
<td>Reinforcing</td>
<td>8</td>
<td>2.23</td>
</tr>
<tr>
<td>Integrating</td>
<td>8</td>
<td>2.03</td>
</tr>
<tr>
<td>Utilizing</td>
<td>8</td>
<td>1.53</td>
</tr>
</tbody>
</table>

Scale  
1 = Slight Impact  
2 = Moderate Impact  
3 = Strong Impact
APPENDIX G. CONCEPTUAL CHANGE INSTRUCTIONAL UNIT

REFLECTIVE JOURNAL ASSIGNMENTS
Lesson 1 Journal (in-class).

Based on the classroom scenario you designed earlier, discuss answers to the three following questions with your new partner. What teaching is, what learning is and what is the role of the computer. Your partner should write your answers down into your journal and ask you to sign it. Proceed to switch sides and repeat the process.

Lesson 2 Journal (in-class).

In the alternative scenario presented by the instructor, is the teacher teaching? Why or why not? Is this learning? Why or why not?

Lesson 2 Journal (out-of-class).

Create a list of common characteristics and themes of teaching and learning across the three reading assignments. In addition, for each of the reading assignments describe what the teacher is doing, what the student is doing, and what is the computer doing.

Lesson 3 Journal (out-of-class).

Based on the common themes and characteristics of teaching and learning drawn from the readings and classroom activities, is this an accurate definition of teaching and learning? Why or why not?

Lesson 4 Journal (in/out-of-class).

Choose one of the three lessons you developed in class and compare and contrast what the teacher does, what the students do and how the computer is being used versus the initial classroom scenario you developed in the first lesson. Time depending, this may be done in-class or out-of-class.
APPENDIX H. CONCEPTUAL CHANGE INSTRUCTIONAL UNIT

EXIT INTERVIEW
Following participation in the instructional unit, each student met with an interviewer to debrief. The researcher for this portion of the study had not previously been involved with the participants. Moreover, the researcher at this point was not an authority figure, but a fellow student. It was believed that having someone who was not an authority figure conduct the interview would allow for more candid answers to the interview questions. During this exit interview each participant returned their completed reflective journal and spoke briefly with the interviewer. The following questions were asked:

- What is your opinion of how the unit was conducted?
- What is your opinion of the content that was taught during the unit?
- Would you use what you learned throughout this unit in your future teachings? Why? How?
- Do you have any final comments in regards to your participation in this research study?
- Have your ideas about teaching, learning, and classroom computer use changed as a result of your participation in this unit?

During this brief interview the researcher will attempt to draw the subjects' true beliefs and ideas in regard to their participation in this research.
APPENDIX I. DATA ANALYSIS MATRIX
<table>
<thead>
<tr>
<th>Research Question</th>
<th>Measurement/Scale</th>
<th>Behavior</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Effectiveness of</td>
<td></td>
<td></td>
<td>Answers to following RQs</td>
</tr>
<tr>
<td>CCIU</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conceptions altered?</td>
<td>Strong change</td>
<td>Strong motivation to expand upon alternative and apply alternative in multiple situations. Never integrates initial beliefs. Strong differences between Pre-1 and Post-1.</td>
<td>PA, L1, L4, EI</td>
</tr>
<tr>
<td></td>
<td>Moderate change</td>
<td>Expressed interest and strong ability to apply alternative</td>
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</tr>
<tr>
<td></td>
<td>Weak change</td>
<td>Acceptance of alternative but still has a tendency to integrate initial beliefs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No change</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RQ. 1</td>
<td>Strong Dissatisfaction</td>
<td>Motivation and excitement toward alternative</td>
<td>L2, J2, L3, J4, EI</td>
</tr>
<tr>
<td></td>
<td>Moderate Dissatisfaction</td>
<td>Strong understanding and acceptance of alternative</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weak Dissatisfaction</td>
<td>Acceptance of alternative</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No Dissatisfaction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RQ 1.1</td>
<td>Strong acknowledgement</td>
<td>Explanation of beliefs to peers</td>
<td>L1, L2, EI</td>
</tr>
<tr>
<td></td>
<td>Moderate acknowledgement</td>
<td>Discuss classroom model and beliefs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weak acknowledgement</td>
<td>Complete classroom model assignment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No acknowledgement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RQ 2</td>
<td>Strong understanding</td>
<td>Strong ability to discuss, apply, and write about alternative</td>
<td>L2, J2, L3, L4, J4, L5, EI</td>
</tr>
<tr>
<td></td>
<td>Moderate understanding</td>
<td>Ability to discuss and write about alternative</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weak Understanding</td>
<td>Ability to answer written questions about alternative</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No Understanding</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RQ 2.2</td>
<td>Strong recognition</td>
<td>Strong ability to discuss, write, compare and contrast initial and alternative</td>
<td>L2, J2, L3, L4, J4, L5</td>
</tr>
<tr>
<td>--------</td>
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<tr>
<td></td>
<td>Moderate recognition</td>
<td>Ability to discuss and write about initial and alternative</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weak recognition</td>
<td>Poor understanding of alternative and recognition of initial</td>
<td></td>
</tr>
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<td></td>
<td>No recognition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RQ 3</td>
<td>Strong acknowledgement</td>
<td>Expressed strong interest and motivation toward applications of alternative</td>
<td>J2, L3, L4, J4, L5, PA, EI</td>
</tr>
<tr>
<td></td>
<td>Moderate acknowledgement</td>
<td>Understanding of alternative and moderate application interests</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weak acknowledgement</td>
<td>Acceptance of alternative</td>
<td></td>
</tr>
<tr>
<td></td>
<td>No acknowledgement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RQ 3.2</td>
<td>Strong application</td>
<td>Integration and expansion of themes and concepts of alternative within several disciplines</td>
<td>L4, J4, L5</td>
</tr>
<tr>
<td></td>
<td>Moderate application</td>
<td>Integration of themes and concepts of alternative</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Weak application</td>
<td>Ability to reproduce alternative</td>
<td></td>
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<tr>
<td></td>
<td>Not able to apply</td>
<td></td>
<td></td>
</tr>
<tr>
<td>RQ 3.3</td>
<td>Strong internalization</td>
<td>Strong ability to explain, personally discuss, and apply alternative in multiple situations</td>
<td>PA, J4, EI</td>
</tr>
<tr>
<td></td>
<td>Moderate internalization</td>
<td>Ability to explain alternative in their own words</td>
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</tr>
<tr>
<td></td>
<td>Weak internalization</td>
<td>Ability to mimic alternative</td>
<td></td>
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<tr>
<td></td>
<td>No internalization</td>
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</tbody>
</table>

**Note:** To meet strongest level for each question, student must encompass traits from all levels for that question unless they are negative (i.e., weak). PA=Preparatory Assignment, L1=Lesson 1, J1=Journal Lesson 1, L2=Lesson 2, J2=Journal Lesson 2, L3=Lesson 3, J3=Journal Lesson 3, L4=Lesson 4, J4=Journal Lesson 4, L5=Lesson 5, J5=Journal Lesson 5, EI=Exit Interview, RQ=Research Question
Research and Guiding Questions

How effective is the Conceptual Change Instructional Unit (CCIU) in creating conditions necessary for conceptual change to occur? As a result of the preservice teachers’ participation in the instructional unit, did the participants alter their conceptions about the role of the computer in teaching and learning?

1. Did the participants become dissatisfied with their existing conceptions?
   1.2 To what extent did the participants acknowledge their existing conceptions about teaching, learning, and teaching and learning with computers?

2. Did the participants make sense of the alternative conception?
   2.2 Did the participants recognize differences between the alternative conception and their initial conception about teaching and learning and teaching and learning with computers?

3. To what extent did the participants acknowledge the viability of the alternative conception? (i.e., did the participants consider the alternative conception to worthwhile, believable, and practical?)
   3.2 To what degree were the participants able to apply the alternative conception to related situations?
   3.3 Do the data suggest that internalization of the alternative conception occurred?
APPENDIX J. PRESENTATION OF QUALITATIVE CASE DATA
Consistent with analyzing qualitative research data and the triangulation process, this research study used the following coding system. This coding system is used within the analysis of each participant’s progression through the instructional unit and describes where the data were drawn from (Table 6).

Table 14. Data Source Coding System

<table>
<thead>
<tr>
<th>Data Source</th>
<th>Code</th>
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<tbody>
<tr>
<td>Preparatory Assignment</td>
<td>PA</td>
</tr>
<tr>
<td>Lesson 1</td>
<td>L1</td>
</tr>
<tr>
<td>Lesson 2</td>
<td>L2</td>
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<tr>
<td>Lesson 3</td>
<td>L3</td>
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<td>Lesson 4</td>
<td>L4</td>
</tr>
<tr>
<td>Lesson 5</td>
<td>L5</td>
</tr>
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<td>Journal Entry 1</td>
<td>J1</td>
</tr>
<tr>
<td>Journal Entry 2</td>
<td>J2</td>
</tr>
<tr>
<td>Journal Entry 3</td>
<td>J3</td>
</tr>
<tr>
<td>Journal Entry 4</td>
<td>J4</td>
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<tr>
<td>Journal Entry 5</td>
<td>J5</td>
</tr>
<tr>
<td>Exit Interview</td>
<td>EI</td>
</tr>
<tr>
<td>Preconception Identification Survey</td>
<td>PIS</td>
</tr>
<tr>
<td>Instructor/Researcher Observation</td>
<td>O1, O2, O3...</td>
</tr>
</tbody>
</table>

This coding system represents the sources of data used in the interpretations.

Holly

Holly was a sophomore majoring in Secondary Education and specializing in Spanish. Holly was a young student who expressed moderate excitement toward education. Over the course of the lesson, she became quite friendly with several of the other students and would occasionally practice her Spanish with William who spoke Spanish fluently.

Holly rated herself as having medium computer proficiency, moderate attitudes about computers in education, and eclectic epistemological beliefs (PIS). Prior to the beginning of the CCIU, Holly expressed her beliefs about teaching, learning, and the role of the computer in the K-12 classroom in the CCIU Preparatory Assignment. Within this opening
assignment, Holly defined teaching as the "passing on [of] knowledge and wisdom to the [students] (PA)." "Learning is taking in new ideas and information to make one self more well-rounded. Learning occurs everyday from how we relate to and interact with others to the actual information we study and absorb (PA)." Holly described the role of the computer in the classroom as being "essential" (PA). She notes that the computer offers students the opportunity to access new and hard to find information via the Internet (PA). "[The computers are also] able to do programs/games that aide [the students'] learning process (PA)."

**Day one.** During the first lesson, Holly worked with Tammy to design their model lesson. Within this lesson Holly described the teacher's role as the "instilling of knowledge upon the students (J1)." In the lesson designed by Holly and her partner, the teacher would instruct the students on how multiplication works and then split the class up into two groups. The first group would practice what they learned using flash cards and the second group would use the computer to play a "Jeopardy" type game to practice what they learned from the teacher. After a while, the two groups would switch places and work within the other activity (L1). Holly stated, "in [her] lesson, the computer acted as a way [for the students] to review and practice [what they learned] (J1)."

**Day two.** The second day began with each group presenting their model lesson to the class. Both Holly and Tammy were enthusiastic about the lesson the designed and both participated in the presentation (O1). During the alternative lesson Holly participated actively with her group; trying to help them solve the problem and talking about where to find the answers (O2).
Day three. During the discussion of the alternative lesson and example lessons form the reading, Holly made many comments about teaching, learning, and the role of the computer. She used words such as: "real world problems, creativity, problem solving, and trusting (L3)." Following the discussion, Holly wrote in her journal that teaching is "guiding self-exploration [rather] than the transmission of facts (J4)." Holly also defined learning as the acquisition of knowledge through self-exploration, teacher-lead activities, and discussion (J4). She described the computer as a tool that can be used to help students solve problems that are introduced to them by the teacher (J4). When asked to compare and contrast the differences between her model lesson and the alternative lesson, Holly stated that in her model, "the computer was used more in a drill-like fashion.... In the [alternative] lesson, the computer was used as an actual teacher while the real teacher played more of a passive, ask-if-you-need-me role. The program didn't use the memorization/drill-like things as in our model, but rather an interactive program where the students were able to learn things on their own (J3)." "[In the alternative lesson, students] will feel like they are doing something and that they are not just doing drills -- that can get boring (L3)." Holly noted that within her model lesson, the activity was lead by the teacher, but within the alternative, the activity was centered on the student and on the student's learning (J3).

Day four. After being introduced to the five pieces of software by the instructor, Holly decided to create her lesson around story-telling software designed by Broderbund. Holly chose to work with this software because it offered the option to work in English or Spanish. Since Holly was studying to be a Spanish teacher, she figured this software would be the best for her.
Day five. In describing the lesson she designed the previous day, Holly explained that the students would progress through the Spanish version of the story (L5). Following the story, "the student's would practice their translating skills by writing a summary of what the story consisted of (J5)." During this activity, the teacher would act as a supervisor to ensure that students were staying on task and be available to help the students and answer any questions that might arise (L5). She stated that, the computer would act as a "tool for learning" by providing all the information about the story, word pronunciation, vocabulary and verb tenses (L5). This would also give the teacher the opportunity to spend more time helping individual students with their questions rather than reviewing vocabulary or verb tenses (L5).

Exit interview. During the exit interview, Holly explained, that participating in the research study "helped to open [her] mind to other possibilities besides teaching from a book or using flash cards.... I can branch out and use some technology and other teaching methods that [she] wouldn't normally consider (EI)." She stated that students learn better when the teacher relates to them. When asked whether or not her personal ideas about teaching, learning, and classroom computer use have changed, Holly noted that, "they have [changed] a little." She described that in her model lesson she integrated a drill and practice game and organized her lesson based on what she had experienced when she was a K-12 student. But, she had understood that different people learn in different ways and teachers need to design instruction that better relates to those different ways of learning (EI).
Tammy

Tammy described herself as a fifth year senior studying Secondary Education. She had been a History student who decided she would acquire a teaching degree. Tammy was a shy and quiet student who appeared to be cautious about using computers in education. At the onset of the instructional unit, she was hesitant to express her thoughts and ideas, but as the research continued she opened up to her peers more. She rated herself as having high computer proficiency, moderate attitudes about computers in education, and eclectic constructivist epistemological beliefs (PIS).

Prior to the beginning of the CCIU, Tammy expressed her beliefs about teaching, learning, and the role of the computer in the K-12 classroom in the CCIU Preparatory Assignment. Within this opening assignment, Tammy described teaching as "sharing knowledge, experience with someone (students) who don't yet have that knowledge. Teaching can be done in many ways: lecturing, researching, in-class activities, [and] group activities... (PA)." In describing learning, Tammy stated that, "learning is when you acquire new knowledge or experience something new and are able to attain and apply what you saw, read, heard, or experienced to your way of life (PA)." In describing the role of the computer, she stated that "the computer is (becoming) a way for teachers to help students learn. There is information available through the Internet. It can be used as a way to do projects such as making presentations.... It is a great tool for both teachers when teaching and students when learning (PA)."

Day one.

During the first lesson, Tammy worked with Holly to design their model lesson.
Day two. When presenting her model lesson, Tammy stated that in this model lesson, "the teacher would have already introduced the topic to the students. The teacher would be available for answering questions and helping with problems. The teacher would be giving positive feedback such as: reinforcing that all questions are good and telling the students that they are doing a great job...(L2)." "The students would be learning more about multiplication tables because they are using them in different settings. The learning would also be a review of what the teacher had taught before (J1)." In describing the role of the computer within the model lesson, Tammy stated that, "the computer would be helping the students with the review, allowing the teacher more one on one time with each individual students (L2)." During the alternative lesson, Tammy was an active participant within her group (O1). She helped to solve the problems her group was given and was excited about coming to a solution (O2).

Day three. During the discussion of the alternative lesson Tammy stated that the instructor in the alternative lesson acted as a resource and helped to direct the class discussion (L3). Although Tammy did participate in the discussion she only offered information when asked a question (O3). Tammy described teaching as "when [teachers] give students the tools necessary for learning a skill or solving a problem, but let them explore and discover the answer on their own [and acts as] a guide and a resource (J4)." She described learning as discovering answers to questions and problems and applying this knowledge into situations in your life (L3). "Learning can take place in many forms such as: hands-on activities, reading, listening, visually seeing an activity or a problem being solved (J4)."
Day four. After being introduced to the different pieces of software, Tammy chose to design a lesson that integrated "Stanley's Sticker Stories".

Day five. In presenting the lesson she designed in the previous class, Tammy said, "the teacher would introduce the software to the students, showing them how the different buttons work by creating the first page of a story. The teacher would start the students brainstorming ideas for their stories. [Afterwards], the students would be divided into groups and asked to create a short story using the software (L5)." In this lesson, the "students would use prior knowledge of creating sentences and also of stories they may have read to create their own stories. The students would develop story-writing skills and strengthen their sentence writing skills (L5)." Tammy noted that the computer in this lesson would be "used as a tool for the students in writing and sharing their stories. The computer would [also] motivate [the students] because it was a new program and it [has] animations (L5)."

Exit interview. During the exit interview Tammy stated that as a result of participating in this instructional unit she has become more aware of how to use the computer in the classroom (EI). "I think now I can see when would be a good time to use computers in learning (EI)." "When we started our lesson plans we were using the computer as a reinforcement, rather than... using it more as a tool to actually have [the students] learn for themselves and act as a resource (EI)."

Alexa

Alexa was a first year student majoring in Secondary Education. Maryann was an average student who often seemed preoccupied. She only spoke when asked a question and wrote in her journal with as short answers. There were several times when I had to ask her to
expand upon what she had written in her journal assignment because she gave such little information.

As a result of taking the PIS, Alexa rated herself as having low computer proficiency, moderate attitudes about computers in education, and eclectic epistemological beliefs. Prior to the beginning of the CCIU, Alexa expressed her beliefs about teaching, learning, and the role of the computer in the K-12 classroom in the CCIU Preparatory Assignment. Within this opening assignment, Alexa defined teaching as "the passing on of knowledge to students (PA)." She defined learning as the acquiring and applying of new skills and concepts (PA). Finally in defining the role of the computer, Alexa stated that the computer can be a great tool in the classroom if used appropriately (PA). She went on to state that the computer can make learning fun and exciting, and "with our growing technological world computer knowledge and use is essential (PA)."

Day one. In designing her model lesson, Alexa worked with Todd (Figure 2). Within their lesson, the teacher introduces basic multiplication concepts, then allowed the students to work at three different stations for about fifteen minutes (L1). The stations she described were: worksheets, math manipulatives, and the computer.

Day two. During the second day of the research unit, Alexa and Todd presented their model lesson. They both did an equal amount of speaking during the presentation, but they seemed to have very different understandings about what the students were doing and explanations about what teaching and learning was within the lesson (O1). In the lesson, she described, the teaching as "conveying information to the students [through] demonstrating and verbally reinforcing the concepts (J1)." She goes on to note that, based on this lesson, learning is "showing a basic understanding of the concepts through successful manipulation
of the manipulatives, the worksheets, and the computer program (J1)." Within this lesson the computer was used to "facilitate" learning through reinforcement of the concepts taught by the teacher (J1). Following the student presentations Alexa was very active in the alternative lesson. She was excited to be doing the activity and was very active within her group (O2). She seemed to enjoy the activity and was very vocal about how the group should solve the problem (O3).

**Day three.** During the discussion on the third day of the unit, Alexa participated tentatively only offering short curt bits of information when asked to answer questions. Following the discussion, Alexa described teaching as "the facilitating of learning (J4)." This might cause some concern because she used the term "facilitating" earlier along with the word "reinforcement" (O4). In this description Alexa continued by stating, "teaching is helping students to reach their full potential by challenging them to think critically, and encouraging them to seek information and use their prior knowledge in a constructive manner (J4)." Within this same assignment she described learning as "the acquisition and application of knowledge (J4)." When asked to compare and contrast the differences between her model lesson and the alternative lesson, Alexa acknowledged that in her model lesson, "the main goal was to introduce multiplication.... That was it. The [alternative] model incorporated teamwork, life skill development, computer skills, problem solving, planning, as well as basic math skills (J4)." In addition, Alexa stated that in her model lesson, "the software used was a reinforcement game, but in the alternative lesson, the software had real-life applications and addressed many more avenues for learning (J4)."
Day four. After being introduced to the different software programs, Alexa hesitated, but then chose to work with the "Hot Dog Stand" software. She worked with the software for w while before deciding as to how she might integrate it into a lesson (O5).

Day five. In presenting the lesson she designed during the previous class, Alexa explained that in this lesson, the students would be introduced to the software and then be asked to solve the problems that are provided through the software (L5). The students, working in groups of two, would start on the lowest level and "explore the software to solve the problems (L5)." In this lesson, the students would develop computer skills, teamwork skills, problem-solving skills, planning skills, and math skills (i.e., estimation, budgeting, inventory, and balancing of accounts) (L5). In this lesson, the computer is enabling to students to learn math skills and real-life problem solving while having fun (L5).

Exit interview. During the exit interview Alexa explained that she learned that "teaching isn't just lecturing (EI)." She stated that teaching and learning can be hands-on and discovery based and that students can actively participate in the learning process (EI). When asked if she had changed her ideas about teaching, learning and classroom computing, she said, "maybe a little (EI)." She said she liked the idea of integrating teaching strategies such as: "group involvement and hands-on experiences.... rather than just having them read a chapter and hoping [the student] absorb it (EI)."

Todd

Todd was a second year student majoring in Secondary Education and specializing in Spanish. Todd was a very studious and well-spoken young learner. Todd had very strong opinions about teaching and learning, in addition his opinions were broad-stroked and
accepting. Todd rated himself as having low computer proficiency, moderate attitudes about computers in education, and eclectic constructivist epistemological beliefs (PIS).

Prior to the beginning of the CCIU, Todd expressed his beliefs about teaching, learning, and the role of the computer in the K-12 classroom in the CCIU Preparatory Assignment. Within this opening assignment, Todd defined teaching as "helping students discover knowledge about themselves, other human beings, life forms and the universe. Teaching is assisting learners to use knowledge in creative ways...(PA)." "Learning is discovering the universe and making sense out of all the details (PA)." When describing the role of the computer in the K-12 classroom, Todd stated, "computers are a tool that can be manipulated in varied ways to provide opportunities that are cost effective [and] that many students might not ever experience anywhere else (PA)."

Day one. During the first class, Todd worked with Alexa to design their model lesson.

Day two. During the second day, Todd and Alexa presented their model lesson to the class. Todd described the teacher's role as "being a guide" and "steering the students in the right direction (L2)." "Students learn better if they uncover or discover the information for themselves rather than having it forced onto them. The learning in the classroom would be something that the students would own, it would not be something that the teacher told them was so (L2)." In this model lesson, Todd also mentioned that the computer would act as a "discovery tool" (J2). The computer would allow students to apply concepts they learned in class as well as support self-paced instruction (J2). In their presentation, Todd and his partner, although they were talking about the same lesson, had very different views of how the students would progress (O1). That is, Alexa used terms such as reinforce and practice
while Todd said discover and experience when talking about the same lesson (O2). During the alternative less, Todd was an active participant (O3). Immediately after his group was assigned their task he took out his calculator, started putting in numbers, and looking for solutions (O4).

**Day three.** As the class discussed the alternative lesson Todd was, again, an active participant and continuously offered his opinions about teaching, learning, and classroom computer use (O5). Todd stated that the computer is used to "collect, assemble, and manipulate information (L3)." In these alternative examples he noted, "the computer is used as a tool to help the students learn (L3)." Todd stated that his original definition did not really change. "Learning is making sense of all the details in the universe (J4)." Teaching involves all the different strategies that offer students the opportunities to discover and learn about the world around us (J4). When asked to compare and contrast the differences between the model lesson designed in the first class and the alternative lesson conducted by the instructor, Todd acknowledged that, "teaching in the original model [lesson] was more traditional and less integrated... (J3)." Teaching and learning in the alternative model involved creative thinking and problem solving (J3). In reference to the alternative lesson, Todd mentioned, "teachers are students and students are teachers (L3)."

**Day four.** After being introduced to the capabilities of the different software programs, Todd decided to design his lesson around a story-telling software designed by Broderbund. Todd was study to be a Spanish teacher and thought that the Spanish speaking software could be integrated well into a lesson.

**Day five.** In presenting his lesson, Todd stated that, "the students will be given the software and asked to listen to the story (L5)." While the students were translating the story
they would also be asked to make a list of the unknown vocabulary words (L5). As a result of this lesson the student would each prepare/create: a vocabulary list of words they did not understand, a transcript of the story in Spanish, a new story using the characters from the story and the vocabulary from their vocabulary list, and finally the students would be grouped together and create a skit based on the story they wrote (L5). During the lesson, the teacher would: help students that were having trouble with the computer or the software, evaluate students' progress, and assist in proper pronunciation practice (L5). Within this lesson Todd noted that the computer would act as a tool in helping the students gather and organize information and be used for drill and practice of pronunciation and translation skills (L5).

**Exit Interview.** During the exit interview, Todd was asked to describe what he meant by discovery learning. It was a term that he had used through the research unit in describing learning and designing teaching. He gave an example of learning how to tie his shoes when he was a child. He said, "that it's like when you have an idea as to how to do something and you finally figure it out all on your own... the light goes on (EI)." "That type of learning is important because it is meaningful and you remember it (EI)." When asked by the interviewer whether he felt his ideas about teaching, learning, and classroom computer use had changed after participating in this research study he said, "I don't know.... It started me thinking more seriously about using the computer and teaching in different ways (EI)."
Maryann

Maryann was a junior majoring in Secondary Education. Maryann was a hard
working student who participated in class. Although she often appeared sleepy, she always
put forth a good effort with class activities and involved herself in class discussions.

She rated herself as having low computer proficiency, moderate attitudes about
computers in education, and eclectic constructivist epistemological beliefs (PIS). Prior to the
beginning of the CCIU, Maryann expressed her beliefs about teaching, learning, and the role
of the computer in the K-12 classroom in the CCIU Preparatory Assignment. Within this
opening assignment, Maryann defined teaching as "the transfer of knowledge and ideas to
others.... I think that an effective teacher will teach in such a way that students just don't
memorize facts and information, but understand when the class is finished, how to use the
knowledge and/or idea and apply it to life (PA)." She described learning as "the
understanding of knowledge and ideas well enough so that they may be applied to the
[relevant] field of study and life (PA)." "If someone can learn something from you, you've
learned something yourself (PA)." Finally, she described the computer as an important part
of the classroom because it plays such a major role in society (PA). "By having students
work with computers in the classroom, they are being prepared for the working world (PA)."

Day one. During the first class, Maryann worked with Joannnifer to design their
model lesson. In the lesson the created, the teacher would introduce basic multiplication in a
simple way, then have the students work with a hand written worksheet followed by a
computer game (L1). The computer game they described was designed around a time-based
test in which as the students answer questions correctly, they would be given harder and
harder questions (L1).
Day two. Day two began with each group of students presenting the model lesson they designed in the previous class. In their presentation, Maryann described the role of the teacher as "a guide and motivator to help the students become familiar with multiplication. In addition, the teacher must [also] lay down the basic foundation of multiplication and act as a guide to [help the students] discover the steps used for multiplication (L2)." In the lesson she designed, she stated that the role of the students "was to be attentive to the material discussed and put effort into practicing multiplication (J1)." Also within her lesson, she noted "the role of the computer was to act as a reinforcer to the multiplication system.... The computer program was [used] as an alternative to flash cards and provide a game-like set-up (J1)."

Day three. During the alternative lesson, Maryann was a leader within her group (O1). She was constantly talking with her fellow students and looking for way to solve the problem and asking where the information needed might be found (O2). After participating in the alternative lesson Maryann had several comments about the characteristics of constructivist teaching, most focused on the differences between the styles of teaching she was use to in K-12 and the teaching strategies employed in the alternative (O3). "This style of teaching is different from the forms of teaching many of us grew up with (L3)." She explained that learning in this alternative lesson "is the exploration and discovery of knowledge that a teacher has provided. Students learn by using and manipulating the knowledge they already have (L3)."

Day four. After being introduced to the capabilities of the software presented by the instructor, Maryann decided to design her lesson around integrating "Stanley's Sticker
Stories. Maryann was studying to become an English teacher and thought that this software would fit well within a lesson she had on her mind.

**Day five.** In presenting the lesson she designed the previous class, Maryann explained that the teacher would start the lesson by reviewing the rules of writing a sentence, followed by having the students writing sentences about what they had for lunch (L5). After the students wrote their sentences, she expressed, the teacher would introduce the software, then ask the students to sit at the computer and use the characters within the software to draw the sentences (J5). She stated that within the lesson, the teacher's role is to "formally explain how a sentence is made and the components that go into making a sentence (L5)." The students' role in this class is to practice forming and writing sentences. In addition, "[the students] are using their imagination skills when they are deciding what they want their sentence to be (L5)." Maryann stated that within this activity, the computer acts as a motivator and "provides an alternative environment for practicing grammar and sentence structure skills (L5)." When I asked her why she designed her lesson in such a manner, she stated that this was the only way the software she chose could be used (O4).

**Exit interview.** During the exit interview, Maryann mentioned that she had poor attitudes toward using computers in education. "You know, these games, sorry activities, you can't just throw kids at them and let them use them. Now, I definitely will be more open to using it in the future (EI)." When asked if she changed her ideas about classroom computer use, she said "yes." She continued by saying, "I probably will use it a little more, but I still think that the teacher is the main source of information and knowledge and the computer can help reinforce [that knowledge].... I will probably use a lot of word processing materials (EI)."
Joann

Joann was a senior majoring in Secondary Education and specializing in English. Joann was a smart student and very excited about education. Joann was always very outspoken, energetic, and enthusiastic during class. She was very popular with the other students, always had active input during the class discussions, and always expressed her mind. She was the type of student that a teacher would remember.

She rated herself as having medium computer proficiency, moderate attitudes about computers in education, and eclectic epistemological beliefs (PIS). Prior to the beginning of the CCIU, Joann expressed her beliefs about teaching, learning, and the role of the computer in the K-12 classroom in the CCIU Preparatory Assignment. Within this opening assignment, Joann described teaching as "a process through which an individual aids another in realizing his or her own potential in learning. Teaching is not a static process, but is always changing and requires open-minded, resourceful, and helpful thinking (PA)."

"Learning is a process through which an individual acquires knowledge, wisdom, and common sense...(PA)." "Learning is intimately connected to teaching; as an individual learns, he or she may understand how others learn and in turn teach others (PA)." When describing the role of the computer in the K-12 classroom, Joann stated, "computers can be very helpful as a means of presentation, dissemination, and facilitation. Using computers [helps] develop skills like those needed for multi-media, technical and research purposes. Computer use can be integrated in the classroom in an interactive, fun, and enlightening way...(PA)."

**Day one.** During the first activity, Joann worked with Maryann to design their model lesson.
Day two. In presenting her model lesson, Joann was excited to tell her fellow students about how she was integrating the computer into her lesson. Joann described that within this model lesson, the teacher "is building upon 'pre-knowledge' in order to help students achieve a higher understanding of multiplication through practice and reinforcement (L2)." Joann stated that in this lesson, "learning is internalized through exercises like hands-on activities, practice and games. It is done through individual; exercises and cooperative learning activities (L2)." Finally, Joann pointed out that "the role of the computer is to provide students with entertaining and educational activities through which they become more familiar with the concepts and applications of multiplication (J1)."

During the alternative lesson, Joann was an active participant. She was the leader of her group (O1). She spoke aloud looking for solutions to the problem and managed the computer for the group (O2). She typed all the answers into the word processor and manipulated the calculator software (O3).

Day three. During the discussion of the alternative lesson, Joann took notes in a word processor so they could be printed and attached to the drawing of the alternative classroom (O4). When asked about the alternative lesson, Joann stated that she felt the goal for the students was to "implement solutions in a real world situation (L3)." "The computer helped to make some tasks easier and offered quick access to information (L3)."

Joann was very extensive in describing new definitions for teaching and learning in Journal 4. She described teaching as "helping students to practice already achieved skill and knowledge levels through interactive learning activities that encourage students to explore and discover on their own. Teaching is making activities more relevant to students' lives so as to help students to extend their skills and knowledge beyond that which they have
previously achieved and to aid students in developing their problems solving skills by way of discovery and exploration (J4)." "Teaching is giving students opportunities to make their own decisions and to have some autonomy in the matter through which they learn on an individual basis (J4)." In discussing learning, Joann stated that "rather than gaining inert knowledge through rote learning, meaningful learning should be a process through which an individual is able to gain knowledge and skills that will be retained in long-term memory and that will be useful in everyday applications. Learning should be an active process with the 'learner' at the center of the action and as the individual around [which] all the activities, questioning and discoveries occur. Learning is taking what current knowledge and skills that an individual has and using those skills to take another step toward another level of knowledge, another level of skill, and another level of application through problems solving rather than memorization (J4)." "If learning is meaningful and relevant, it will both increase the likelihood that the student will retain the learning as well as increase the likelihood that students will apply the learning to real life experiences either now or in the future (J4)."

When asked to compare and contrast the differences between her model lesson and the alternative, Joann stated that, in the alternative "the teacher is a facilitator and an organizer. He/she provides a scaffolding or a model by which students can solve problems presented to them. Teachers are not just 'giving information' to the students to regurgitate...(L3)." In the alternative lesson, the teacher "stands back and advises students with their exploratory activities (J3)." In respect to the students, Joann noted that, "students become active members in constructing knowledge for themselves rather than being the passive recipients of knowledge from their teacher. [Also], students make 'real-world' connections that help them to make the problem solving relevant to themselves and their own
life (J3)." Finally, in reference to the role of the computer, Joann acknowledged that, "the computer's role [in the alternative] is to act as a tool through which the students and the teacher can enhance the learning process. It is an important aid insofar as it provides a platform for visual aids, a platform for organization, and a platform for [creating] a finished product (J3)."

**Day four.** After being introduced to the different pieces of software, Joann decided to create a lesson that integrated "Hollywood High" and "Inspiration" into an English class. The instructor did not present Inspiration software, but Joann had used it before to make concept maps and thought it would be a good addition to her lesson.

**Day five.** During the final day, Joann presented her new lesson to the class. During the presentation, Joann stated that the students would work in groups to create a "survival situation" (L5). The idea for the "survival situation" would be brainstormed and mapped out using Inspiration (L5). Following development of the idea, the students would use Hollywood High software to create and act out a play (L5). The teachers role would be to: introduce the problem and the software, and to motivate, and offer students support (L5). Within this lesson, the computer would act as a "tool that students could use to help them brainstorm, create, publish, and present their finished product (L5)." "The computer would [also] help students to assemble, manipulate, and organize information (L5)."

**Exit interview.** During the exit interview Joann said that she was a senior and had had experience with theories of teaching, but it was always abstract and not really connected to anything. As a result of this research, she stated, "I learned a lot more about applying the theories (EI)." She stated, "when we first began, I think most of us were used to [the] drill and practice [use of computers]. As we progressed through the research and through the
different activities.... We learned more about how else we can use [computers] instead of just drill and practice.... We actually used [computers] for relevant learning (EI)." "I came away with more knowledge than I had previously, [I now have more of an] open mind as far as to what I could possibly use technology for. If you sat me down and asked me how might I use [the computer] in a classroom [lesson], I would probably just rack my brain.... Now I at least have ideas and will try to think of different ways to integrate [the computer] into the classroom (EI)."

Alyssa

Alyssa was a first year student majoring in Secondary Education. Alyssa carried an aura of nervousness and inexperience, she often took longer than any of the other students to complete the projects, she was tentative when asking and answering questions, and was very quiet during class discussions and when working within groups.

She rated herself as having low computer proficiency, moderate attitudes about computers in education, and eclectic constructivist epistemological beliefs (PIS). Prior to the beginning of the CCIU, Alyssa expressed her beliefs about teaching, learning, and the role of the computer in the K-12 classroom in the CCIU Preparatory Assignment. Within this opening assignment, Alyssa wrote that teaching is the "bestowing of knowledge to others (PA)." "Teaching should be done in a manner that maximizes the comprehension of those who are on the receiving side." She went on to describe learning as "the process of taking in information (PA)." Finally she stated that the role of the computer is to "enhance education" and should be used as a tool to expand on the basics of what is being taught (PA).
Day one. During first class, Alyssa worked with William to design a model classroom in which the computer was integrated into a lesson where third grade students were being taught multiplication. Within this lesson Alyssa and William described the role of the teacher as presenting and introducing the basics of multiplication. "The teacher would explain the basics of multiplication and division to the students and go over their times tables (J1)." Following instruction the students were given worksheets to complete. After the students showed "good comprehension of the materials presented, they would be paired together at a computer to work with Math Blasters. In this manner, the computer is used to reinforce what the teacher had previously taught and the students had the opportunity practice what they had learned (L1)."

Day two. The second day opened as each group presented their model lesson the their peers. In their presentation, William did most of the talking as Alyssa stood behind him and agreed, offering little information in addition to what William had said (O1). Following the student presentations, the instructor conducted an alternative, constructivist-based lesson with the participants. During the alternative lesson, Alyssa was quite quiet and did not offer much input to the group of students she was working with (O2). Following participation in the alternative lesson, the preservice teachers were asked to compare and contrast the differences in the role of the teacher, the students, and the computer between their model lessons from the first class and this alternative lesson conducted by the instructor.

Day three. During the third day, the class discussed the alternative lesson's characteristics (i.e., role of the teacher, role of the students, and role of the computer). During this discussion, Alyssa again had very little input, but she did mention that the alternative lesson as well as the example lesson in the reading offered the students the
opportunity to solve problems for themselves in real-world situations (L3). Journal three asked the students to discuss the differences between the alternative and example lessons and their model lessons, Alyssa noted that in the model lessons, the teacher "did most of the work (J3)." The teacher used resources such as worksheets, hands-on tools, and drill and practice computer games for the students to apply what they learned (J3). In the alternative lesson the student were in charge of their learning, the teacher acted as a guide and only intervened when necessary (i.e., students were having problems) (J3). Journal 4 was a take home assignment and asked the students to create new definitions for teaching and learning based on the classroom readings and activities. In describing a new definition of teaching and learning, Alyssa defined learning as "the process of taking in valuable information through experimentation and discovery that produces a sense of great accomplishment that has 'applicable to life' results. In the model lessons the computer was used for games that "drilled rather than encouraged discovery (J4)." The computer in the alternative lesson, "was used a tool that aided in problem solving and provided real-life application (J3)."

Day four. During the fourth lesson, the preservice teachers were introduced to five different pieces of software. After an overview of how each of the software programs can be manipulated, the participants were asked to choose one of the software programs and design an instructional lesson that integrates that program. Alyssa chose to work with the "Hot Dog Stand", a math based software program that asks the students to maintain a hot dog stand in a stadium.

Day five. Within her lesson, Alyssa stated several goals, as a result of this lesson the students will be able to gain exposure to business concepts such as inventory, budgeting, comparison-shopping, and consumer trends. In this lesson, the teacher would introduce the
software, separate the students into groups and ask them to solve the problem presented by the software. Once the lesson is underway, the teacher would then act as a coach and help the students with any problems they might be having with the software or with solving the problem the software presented. Finally, in this lesson she described the computer as having the role of a "tool that the students use to gain knowledge about various personal business management skills" and offer a real-world situation (L5).

**Exit interview.** During the exit interview Alyssa explained, "I especially liked the [alternative lesson]... Most of our [model] lessons involved just lecturing and the teacher doing all the work. His examples let the computer do a lot of the instruction and allowed the students to learn throughout. I think it was better all around for everybody, teacher and students (EI)." When the interviewer asked Alyssa if her ideas about teaching, learning and computer use have change, she replied, definitely. "Before I thought I was going to have to pretty much stand up in front of the class and lecture all the time. That is what I experienced as a student, the teacher lectured. But with Bill's example I learned that there were different ways of teaching that were probably more effective that just standing there and lecturing to the students. I am hoping that I can remember some of these as I go through the education college here and remember that there are different ways of teaching and methods that allow the students to be more involved and seem to be more effective. (EI)."

**William**

William was a graduate student studying Educational Computing. William had received his PhD. in sociology several years ago from the State University of New York. William was raised in Mexico and spoke English quite well although it was sometimes hard
to understand him. In addition, he sometimes had trouble understanding what was expected of him in respect to the journal assignments. Finally, William often analyzed what I was trying to do with the instruction and why I was trying to do this. This sometimes resulted in odd questions that were off topic. I often had to ask him to hold the question and ask me after class.

As a result if the PIS, William rated himself as having low computer proficiency, moderate attitudes about computers in education, and eclectic constructivist epistemological beliefs. Prior to the beginning of the CCIU, William expressed his beliefs about teaching, learning, and the role of the computer in the K-12 classroom in the CCIU Preparatory Assignment. Within this opening assignment, William described teaching as "the activity by which knowledge is transmitted and facilitated through different persons involved in the teaching and learning experience (PA)." He stated that, "learning is the process by which we incorporate new knowledge about different subjects.... The learning process can be very exciting if adequate and formidable conditions for learning exist (PA)." In discussing the role of the computer in the K-12 classroom, William noted that, the computer "can facilitate the process of learning providing access to different sources of information facilitating new for of [more individualized] learning (PA)."

Day one. During the first activity, William worked with Alyssa to design their model multiplication lesson. When working on this activity, William had several concerns. His main concern was that "you can't teach multiplication in one lesson." I told him to just take an aspect of multiplication or the introduction of multiplication and design his lesson around that piece. His final lesson consisted of a week's worth of classes that he described as "a real long lesson" (L2).
Day two. When describing the teacher’s role within this model lesson, William stated that, the teacher is "motivating interest in learning new things (L2)." In addition, he stated that the teacher is "providing support, both morally and practically in terms of providing tools for implementing specific activities (J1)." When describing the role of the student, William stated that the student is practicing what the teacher taught (L1). His answer seemed to be vague and mixed within his discussion of the role of the computer (O1). He stated that, "learning with a computer in the classroom would provide the students with access to sources of different types of information (J1)." He continued to mention that, "the role of the computer in the [model] lesson [was] to facilitate practice and introduction to new topics. It would change the dynamics of the class by forcing the class to find its [own] way of doing things. The computer in the classroom could break traditional models, and give the teacher more flexibility (J1)."

Day three. During the discussions on the third day, William had several comments as well as questions. His main concern was in reference to the students being able to do the activity explained in the alternative lesson, although he thought it would be useful (O2). He often had trouble seeing the computer as more than a machine used in the lesson (O3). He said, "the students work with the computer to develop technology skills (L3)." "The computer can be a resource and offer quick access to information (L3)." After participating in the alternative lesson, William described teaching and learning as "a cooperative experience in which the boundaries between both are blurred. Both activities require imagination and creativity.... Learning and teaching can be more meaningful when linked to real-world situations. In the process of teaching and learning, technology can play a very
important role serving as a tool that facilitates the accomplishment of tasks [and] facilitates
new forms of communications and access to information (J4)."

**Day four.** After being introduced to the different pieces of software, William
decided to design his lesson around "Imagination Express: Rainforest". William spent a long
time looking over the software (O4). He was very concerned about the student's ability to
use this software without being taught (L4). In addition, the software was designed to be
able to make a video about the rainforest using characters, animals and animations. William
spent all his time with the looking at the encyclopedia-type information about the people who
live in the rainforest. He did very little with the video and animations portion of the software
(O5).

**Day five.** At the onset of this lesson, William presented his lesson. He stated that,
the teacher would begin by asking questions while introducing the topic of cultural diversity
(L5). The teacher would ask questions such as:

- Do people from different countries and regions have different cultures and life styles?
- Can you name an example of a different culture and life style?
- What factors attribute to these differences? (L5)

He went on to note that, after a short discussion resulting from the questions, the students
would be introduced to the software, and divided into groups (L5). "After being taught how
to use the software, the students would then explore the software and play with the part about
the Kuna [people] (L5)." Following a short time, the teacher would begin a discussion about
the Kuna people by asking several questions (L5). William explained that within this lesson,
the students "participate by sharing knowledge about the software and about the cultural
differences with which they are familiar with.... They [also] participate by trying to answer
the questions introduced by the teacher... (L5)." In this lesson, "the technology is used to present the software program and allow the students to gain information about the Kuna [people]. It facilitates the role of the teacher as the source of information (L5)."

**Exit interview.** During the exit interview, William appeared to be more interested in the research process being employed than in answering the questions from the interviewer. William stated that, "throughout the research study he often felt rushed (EI)." He said, that he is "concerned about the cultural differences" he like the way a lot of the activities were group oriented and not focused on competition. "American education has this obsession with competition, who is first, and I think it limits the amount of cooperation (EI)." When asked if his ideas about teaching, learning, and classroom computer use changed as a result of participating in this research, he said "I don't think they changed a lot (EI)." He said, "I am curious about this.... But, you have to contextualize where and when you use it.... For instance what constraints might [you] have, say you're teaching in a certain institution with certain rules and processes." He mentioned that he likes the idea of using technology in the classroom, but he would also consider using tradition technologies such as blackboards and overhead projectors (EI).