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The Nature of Pedagogical Practices Influenced by an Instructor's Beliefs in an Online Mathematics Education Course

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COLLEGE OF EDUCATION

THE NATURE OF PEDAGOGICAL PRACTICES INFLUENCED BY AN
INSTRUCTOR’S BELIEFS IN AN ONLINE MATHEMATICS EDUCATION COURSE

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This qualitative case study evaluated an instructor’s practices and decision making in the online course, *Seminar in Teaching Geometry*. The focus of the data analysis was to understand and evaluate the instructor’s decisions as they were influenced by the association of belief dimensions and learning-centered orientations. The results were coded based on my interpretation of the framework presented by Samuelowicz and Bain (2001). This framework explains that there are nine belief dimensions and four learning-centered orientations. The data collection involved one case (the instructor), examining the relationship between this instructor’s decision making, class activities, and responses from two students. At the conclusion of the study I presented a model that detailed the findings of this instructor and this online mathematics education course. The model identifies belief dimensions and learning-centered orientations associated with this online mathematics education course. This model will help educators, institutional administration, and students understand the dynamics of an online environment, in hopes of enhancing the experiences for the students and the instructors.
CHAPTER 1: INTRODUCTION

Technology and Mathematics Education

Technology exists in practically every facet of daily living and because of its long standing existence it was the inevitable that technology would also permeate the educational system through distance education. From its inception, distance education has continued to move through colleges and universities (Sherry, 1996). The World Wide Web has changed the Internet to the extent that it has become a transparent asset and resource for education; since the 1980s colleges and universities have accepted that the Internet and the computer have enhanced the educational experience (Clark, 1983; Wang & Chee, 1991).

Distance Education and Mathematics Education

Distance education has entered the mainstream of instructional delivery systems for post-secondary courses and degree programs and because of this educators, find themselves moving away from the so-called “traditional classroom” into distance education (Broady-Ortmann, 2002). The mathematics educational experience is one of learning to teach mathematics and gaining an in-depth understanding of the development of teaching strategies and methods, which Ball (1989) terms as pedagogy. Mathematics education programs intentionally focus on the application of higher-order thinking as it relates to preparing teachers to teach mathematics. Students enrolled in these programs must commit to becoming effective teacher and must recognize that their pre-conceived thoughts and beliefs of teaching will be challenged (Ball, 1990a; McDiarmid, 1992).

Online Education

Many mathematics education degree programs in the United States have incorporated distance learning education courses (Wang & Chee, 1991). Distance education is broad, and is composed of several different platforms:

- web-based, online, and virtual and e-learning: no face-to-interaction
- satellite: remote learning, limited to no interaction with the instructor
- computer based, distributed, and networked learning: interactive educational activities and software,
• blended learning: combination of online and face-to-face,
• video/audio tape: on interaction with instructor (Ally, 2004; Smith, Smith & Boone, 2000).

I am interested in online courses with no face-to-face interaction while learning through the Internet (Caliner, 1999). Because of this interest, I conducted a pilot study to examine instructional methods for promoting student learning in a web-based mathematics classroom. Although the pilot study started with a broad scope, the outcomes of the pilot precipitated a more refined research need.

The Pilot Study

During the Spring of 2004, I conducted a pilot study, entitled *What Are The Most Effective Instructional Methods For Promoting Student Learning In A Web-Based Mathematics Classroom?* At the onset of this study I thought I wanted to discover the impact of learning styles in an online mathematics education course by understanding the influence that learning styles have on distance learning as it relates to a mathematics education course. While conducting the pilot study, I found that students believed the instructor was the common thread to assist them with knowledge construction in an online mathematics education course.

Pilot Study Methodology

To analyze the perceptions of instructional methods in a web-based mathematics education class, I used a qualitative case study approach where I viewed the online course as my case. During the pilot study, I was a participant observer and interviewed three of my fellow peers while we were enrolled in “Analysis of Student Learning”, a web-based mathematics education course. The students (Table 1.1) were selected based on their response to an email asking for volunteers.
Table 1.1

Summary of Participants of the Pilot Study

<table>
<thead>
<tr>
<th>Descriptor</th>
<th>Age</th>
<th>Degree Program</th>
<th>Current Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Mother</td>
<td>30</td>
<td>Masters</td>
<td>Part-time student&lt;br&gt;Works on campus in the biology department&lt;br&gt;Taught middle school mathematics&lt;br&gt;BS in Mathematics Education&lt;br&gt;Single mother</td>
</tr>
<tr>
<td>The Student</td>
<td>23</td>
<td>Masters</td>
<td>Full-time student&lt;br&gt;No teaching experience (student teaching for degree only)&lt;br&gt;BS in Mathematics Education&lt;br&gt;Would like to teach at the high school level</td>
</tr>
<tr>
<td>The Professional</td>
<td>45</td>
<td>Masters</td>
<td>Part-time student&lt;br&gt;High school teacher&lt;br&gt;Has taught for several years at various schools&lt;br&gt;Mother and Wife</td>
</tr>
<tr>
<td>Participant Observer</td>
<td>29</td>
<td>Doctorate</td>
<td>Full-time student&lt;br&gt;MBA, BS in Mathematical Science&lt;br&gt;Aspiring to teach at the collegiate level</td>
</tr>
</tbody>
</table>

Pilot Study Theoretical Framework and Findings

The findings of the pilot study were analyzed using a design framework (Mishara, 2002) for online learning environments. This conceptual framework is based on three learning theories that are represented in an online course: behaviorism (Rilling, 2000), constructivism (Oliver & McLoughlin, 1999), and cognition (Fielding, 1989). Figure 1.1 shows the consideration of the corresponding instructional methodologies to these theories: content, learning activities, learner support (Zaharias, Vassilopoulou, & Poulomenakou, 2001).
This particular framework is interesting because it intertwines three learning theories and adequately situates them with instructional methods. This design framework can be used as a catalyst for future studies; for the purpose of my pilot study I only discussed the instructional methods of learning activities, learner support, and content knowledge.

The findings of the pilot study were based on ideas and data gathered from the students’ perspective. To analyze the data I coded the data in three categories: 1) Content: this involved the instructor’s style, 2) Learning Activities: this detailed the student's expectations of the instructional methods and 3) Learner Support: which detailed the instruction and initiative of the instructor. These coding categories are components of the design framework; these categories allowed for a more direct relationship to the conceptual framework and literature.
Table 1.2
Approaches to Instruction

<table>
<thead>
<tr>
<th>Learning Theories</th>
<th>Basic Instructional Approaches</th>
<th>Online Approaches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Behaviorism</td>
<td>Instruction is designed to promote individual pacing and progress</td>
<td>Lessons with detailed objectives</td>
</tr>
<tr>
<td></td>
<td>Instruction is designed using task analysis</td>
<td>Use of embedded self-assessment questions as interactive activities in the learning materials</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Step-by-step description of learning materials</td>
</tr>
<tr>
<td>Cognition</td>
<td>Instruction is designed to promote processing activity</td>
<td>Use of note-taking and annotations</td>
</tr>
<tr>
<td>Learner Support</td>
<td>Assessment activities rely on observable behavior.</td>
<td>Instructions for learning to learn</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Peer-assessment of learning</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Information seeking using search engines</td>
</tr>
<tr>
<td>Constructivism</td>
<td>Learning is understood as interpretative and emergent, and under the control of the learner.</td>
<td>Use of discussion forums and chat (both synchronous and asynchronous techniques)</td>
</tr>
<tr>
<td>Learning Activities</td>
<td>Knowledge is negotiated meaning and should be achieved via collaborative group work.</td>
<td>Email transfer</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Group projects</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Provision for social activities on the net</td>
</tr>
</tbody>
</table>

This study has been developed to explore instructional methods, in an effort to provide insight on what students think is effective instruction and to also assess what the research and literature detail as far as instructional methods and procedures. To maintain the clear intent of the pilot study, I coded and organized the findings using the indented sub-heading (referenced in Table 1.2) of the learning theories. The indented sub-headings represent the connection between learning behaviors and instructional approaches.

One of the overall assumptions of the content category as it relates to this design
framework is that learning is achieved through frequent response and immediate reinforcement of appropriate behavior; behavior and performance are seen as useful outcome of learning behavior (Mishara, 2002). Through the responses of the three participants, the synopsis of their responses was similar to the ideas presented in Table 1.2. The students collectively described the content component of the design framework as an essential component of online education. While evaluating my own experience in this web-based class, I really appreciated the syllabus, course calendar, the assignment descriptions being posted on the first day. Having these documents available really allowed the nervousness of the unknown to subside.

Learner support assumes that new information is built on existing structures also relevant processing activities are taught to assume that learner efficiently acquires knowledge or solves the problem. The participant interviews revealed that students did not realize the opportunities for students to effectively build on prior knowledge. The observations did support that the online learning environment was set-up to guide the students learning, not force through rote assignments. The students that I interviewed really do not see this component in this class or in their past online learning experiences. Learner support also involves peer assessment, and it was observed that students typically responded heavily and more in-depth at the beginning of the course. As the course progresses, students responses were minimized, once the class got more involved students did not take the time to voluntarily respond. The student responses did not support this component, but the observations do support the component (learner support). It appears almost necessary for learning in an online environment to build on prior knowledge.

One of the overall assumptions of learning activities is learning is understood as interpretive and under the control of the student also that knowledge is really a form of negotiated meaning. The participant responses during the interviews were in-line with principles of the design framework, but the participants did not necessarily feel that purposeful learning activities were possible or attainable in online learning courses.

Summary/Conclusion of Pilot Study

It was not surprising that instruction is integral to students learning, being that is it also integral in face-to-face instruction. In the pilot study, I wanted to explore instructional methods. With web-based mathematical classes, or web-based classes in general becoming more prevalent within the past decade, it is difficult to add closure to any one topic in this area. Though this is small pilot study, I feel it can serve as an introduction to many topics of interest.
The study revealed that teaching over the web requires strategy and forethought. The participants were successful if success is measured by grade, but the experience was not necessarily enjoyable; it was tolerable, but not interesting. Why is that; what does the literature attribute to this; what does the literature suggest? Though this study is not designed to answers these questions, the general consensus of the literature are that instructors must be creative, knowledgeable, and should engage the students, and ensure that the students remain on task (Ally, 2004; Rovia, 2002). The study did not take into account the instructor’s opinions, beliefs, or the pedagogical practices. This omission has left a great opportunity for me to continue this line of research.

**Overview of Online Courses in Relation to the Instructor**

The pilot study and researchers detailed in this section support the need to understand more about online education and the influences of instructor beliefs, and pedagogical practices in mathematics education. Kinney and Robertson (2003) confirmed that the technology used to deliver the online course should not be viewed as the measurement of success; instead it should be viewed as a vehicle that delivers instruction. Computers and the World Wide Web are more like the instruments in online learning that provide processing capability and deliver the instruction to learners. Clark (1983) observed that the true test of learning is more related to instruction, the students, and the students’ ability to receive and internalize the subject matter.

Given these accounts of learning in an online course and the findings of the pilot study, my interest to continue researching the implications of the instructor in an online learning course grew. Online learning is quite promising and, with commitment and resources, it could be of value to the educational system (Rossett, 2002). This possibility offers a great hope towards the evolution of online education. When reflecting on the commitment and resources used to promote mathematics education, that is, learning to teach, learning to observe, learning theories and best educational practices, I realized that mathematics education in some universities, intentional or not, was tailored to teaching within the traditional face-to-face classroom due by in large to the traditional classroom being the historical educational delivery method.

It would be interesting to determine if instructors of online mathematics education courses rely on the pedagogical knowledge learned through a mathematics education program

---

1 Pedagogy is the process through which teachers are encouraged to know, to form a particular
(one end of the spectrum); or do the instructors need to know nothing about teaching methods (the opposite end of the spectrum); or is the role of the instructor in the middle of the spectrum? Rossett (2002) states that learning in online courses is not due to the technology used in the instruction, but to the instructional methods built into the learning materials. Learning is influenced more by the content and instructional strategy than by the type of technology used to deliver instruction.

Web-based instruction can be considered a dynamic system that encompasses components of instructional beliefs, establishment of community, the understanding of the students and the students’ ability to learn in that environment (White & Weight, 2000). The following sections briefly explain instructional theories and the establishment of community, as each of these components relate to the instructor, which is the core of this research study.

**Instruction Associated with Learning Theories**

Based on the workers of researchers, such as Mishara (2002), Zaharias, Vassilopoulou, & Poulomenakou (2001) and Huang (2002), the learning theories most apparent in online courses are:

- **Behaviorism**: actions through personal observation and interaction
- **Social cognition**: students learn by engaging their ideas and experiences with others through collaboration and communication
- **Constructivism**: giving the learners an opportunity to construct their own knowledge.

These learning theories directly influence instructional beliefs which are important and will impact the instructors’ actions within the online course. Instructors may incorporate any combination of the three and if a strong believer of one, may focus their instructional practices to that theory. The instructor is influential to the learning experience, lending credence to the fact that instructional decisions impact student learning (Garrahy, 2001). Regardless of the instructional belief, it is important to understand the types of learners or the potential of varying types of learners (Duffy & Cunningham, 1996; Guanawardena, 1995; Huang; Lainema 2003; Topper, 2003).

Online learning must create challenging activities that allow the learners to link new and way of ordering what teachers know, making sense of what teachers know, and sharing what teachers know (Simon, 1992).
old information together. This level of higher-order thinking must be supported by understanding and utilizing learning theories as the basis for instruction. The emphasis on learning theories is necessary because it has an impact on instruction, which confirms again that it is the instructional strategy and not the technology that holds the greatest sway on the quality of learning (Bonk & Reynolds, 1997). Students and instructors must realize that the nature of an online environment does not lend itself to thorough and detailed guided instruction, especially online environments that are completely asynchronous, meaning that learning is not occurring at predetermined or regular intervals (Oliver & McLoughlin, 1999).

**Online Community**

Not only are instructional methods important to the success of online courses, so are the online community and the establishment of community. During the previously conducted pilot study, the participants often discussed the atmosphere of the course, the lack of communication, the sometimes limited amount of interaction as barriers to enjoyment of the online learning environment. This revelation has led me to further research these components. In doing so, I find that there are more components of online instruction (see Table 1.3).

Table 1.3

*Components in Online Community*

<table>
<thead>
<tr>
<th>Component</th>
<th>Descriptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication:</td>
<td>Instructor to Student</td>
</tr>
<tr>
<td></td>
<td>Instructor to Course Materials</td>
</tr>
<tr>
<td></td>
<td>Must be effective and should initiate a strong and interesting interaction among the students and the instructor (Beaudoin, 1990; Carr-Chellman &amp; Duschatel, 2000)</td>
</tr>
<tr>
<td>Interactivity</td>
<td>Facilitated by effective communication</td>
</tr>
<tr>
<td></td>
<td>Must be maintained by students and instructors</td>
</tr>
<tr>
<td></td>
<td>(Thorpe, 1998)</td>
</tr>
<tr>
<td>Task</td>
<td>Should be original and vary in interest</td>
</tr>
<tr>
<td></td>
<td>Should be challenging, but not too challenging that it deters students</td>
</tr>
<tr>
<td></td>
<td>Used to develop effective learning strategies</td>
</tr>
<tr>
<td></td>
<td>(Ames, 1992; Ball &amp; Bass, 2003; Wilson &amp; Kenney, 2003)</td>
</tr>
</tbody>
</table>
Table 1.3 – continued.

Components in Online Community

<table>
<thead>
<tr>
<th>Component</th>
<th>Descriptors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Work</td>
<td>Gives all students an opportunity to reinforce learning skills and concepts. Creates an environment where teachers and learners work together to develop knowledge. (Thorpe, 1998)</td>
</tr>
<tr>
<td>Pacing</td>
<td>Should be maintained. Provides purposeful pressure to achieve a certain amount of study by a certain time. (Beaudoin, 1990; Harrington, 1999; Thorpe, 1998)</td>
</tr>
<tr>
<td>Assessment</td>
<td>Should be clear and concise. Offers an expectation of the instructor and the class. Is an opportunity for active engagement. (Carr-Chellman &amp; Duschatel, 2000; Jonassen, Carr, &amp; Yeuh, 1998)</td>
</tr>
</tbody>
</table>

**Purpose of the Study**

After being a student of an online mathematics education course, I began to formulate questions about the facilitation of the course. I had my own thoughts about the course, but wondered what other students felt and what the instructor thought about the experience of being an online instructor. This was the point at which I knew I wanted to research online learning. Knowing that I was not completely sure of what I wanted to study or what was involved in online learning, I conducted a pilot study. As explained earlier in the text, the pilot study began with one focus (student learning theories) and ended with a different focus (instructional methods). With the results of the pilot study being the driving force, in addition to recalling my personal experience in web-based mathematics education courses and considering what I found in the literature, it became necessary for me focus on the instructor, specifically teacher beliefs and the influences beliefs have on pedagogical practices. Brickhouse (1990) states that teacher’s beliefs have a direct relationship to instruction in the classroom; to take this a step further I refine my research to an evaluation of instructor beliefs dimensions and learning-centered orientations.
in an online mathematics education course.

The literature supports the idea that it is important not to simply teach mathematics, but to offer effective instructional methods and foster a community that provides the students an opportunity to construct knowledge in an online environment at the same or better level of comfort and support they may have grown accustomed to in a traditional classroom (Duffy & Cunningham, 1996). There are numerous reasons a student would enroll in a distance learning course. The issue then becomes whether a student can adapt and learn in a distance-learning environment, namely web-based/online classrooms. Additionally, does the student’s success or failure depend on the manner or style of the instruction, the instructor’s beliefs, the interactions of the instructor, or the student’s drive or a combination of these (Bonk & Dennen, 1999)? As an instructor who believes in constructivism and the opportunities of in-depth understanding it creates for students, it would be my ultimate desire to promote and educate readers and the educational community of the impact of the successful infusion of constructivism and effective pedagogical practices in an online learning course. I would like my students to value the learning experience of the online mathematics education course.

Oliver and McLoughlin (1999) state that mathematics education has grown from a student-focused platform to education that considers the entire learning experience which involves both students and instructors. Students and instructors should collectively take responsibility for course design, evaluation of the course content and the teaching methods used in web-based instruction. They continued and state that there has been great focus on the students and the students’ needs in education and students’ feelings about online education, but very limited research on the instructor or the instructor’s beliefs and practices in online mathematics education courses. This omission further supports the basis for this study.

**Research Questions**

Online education is described as a teaching and learning situation where the learner is at a distance from the instructor; the learner uses a computer and the Internet to access the learning materials, and uses these technologies to interact with the instructor and other learners (Ally, 2004). This study addressed the instructional experience in an online mathematics education course. I analyzed the instructor’s beliefs, communication and interaction patterns, identified how web-based classroom encouraged online discussion, demonstrated the necessity of constructivist principles, and analyzed the instructor’s role in a web-based classroom. The
primary research question guided this research in addressing the pedagogical experience of web-based mathematics education.

1. What model can be produced when examining an online mathematics education course using a framework focused on instructor belief dimensions and learning-centered orientations?

To fully address this question I also needed to assess belief dimensions and learning-centered orientations separately. To reach a conclusion on these two characteristics I also attend to the following secondary questions:

   1. What are the learning-centered orientations of the instructor’s online teaching practices?
   2. How do the instructor’s belief dimensions influence his online teaching practices?

**Summary**

This chapter provided an introduction to this research study. The introduction gives a brief description of the topics that inspired this study: mathematics education, distance education, online courses, and instruction. This chapter summarized the results of a pilot study. The pilot study further defined and inspired the direction of this study. The following chapter will describe the literature reviewed that I considered relevant to this study.
CHAPTER 2: REVIEW OF THE LITERATURE

This study explored instructor’s beliefs that influence pedagogical practices through learning-centered orientations in an online mathematics education course. The review of the literature begins by describing mathematics education when it incorporates online learning. Understanding that mathematics education, online learning, and distance learning are dynamic systems; and because these entities are too dynamic to define, the literature explains these concepts in the perspective that relate to focus of this study. To other researchers, the definitions included in this paper may not be viewed as the only definition, nor should they be. The complex nature of these subjects causes the definitions to vary based on the perspective. Before being able to adequately describe the implications of learning theories and the impact they have on the beliefs and pedagogical practices in an online course, it is necessary to describe the characteristics of online learning – as they relate to teaching and learning in mathematics education. Online instruction and traditional face-to-face classroom instruction are different, and the difference is driven by the medium of delivery (Smith, Smith, & Boone, 2000). It is appropriate to define and discuss the benefits (advantages) and disadvantages, as well as describe the learning theories (socialism, behaviorism, and constructivism) associated with online learning as they influence instructional decisions. The literature then accounts for the fact that learning theories specifically constructivism, directly influence the community of an online learning environment.

The overarching goal of this study is to examine an instructor’s beliefs and learning-centered orientations in an online mathematics education course by considering many of the characteristics of online learning, and determining the implications of those characteristics would have on pedagogical practices. Pedagogical knowledge and pedagogical content are well researched concepts of education. Pedagogical knowledge is dynamic system of knowledge; it encompasses every facet of instruction and the ability to identify with the learners. To fully engage the learners, pedagogy requires the instructor to have a deep understanding of the subject matter. Because of the sometimes unavoidable tendency to discuss subject matter and pedagogy, some researchers found it difficult to differentiate pedagogical knowledge and pedagogical content, so they have married the two – pedagogical content knowledge (Shulman, 1986;
Remillard, 2000); for this research pedagogical knowledge and pedagogical content knowledge are classified as pedagogical practice.

This research has been informed by the literature on mathematics education, online learning, and teacher beliefs. There is an abundance of work on each of these areas, but the current literature does not specifically address the nature of pedagogical practice influenced by instructor beliefs of an online mathematics education so merging these phenomena provide justification for inquiry. A comprehensive review of the literature will describe these components, by organizing the literature into five main sections:

1) A definition of mathematics education.
2) A historical description of online education, starting at distance education.
3) The characteristics of online education, which includes the advantages, disadvantages, and the overall community.
4) The characteristics of the instruction which presents the components of instruction and the associated with learning theories (behaviorism, socialism, and constructivism) of online instruction.
5) A description of teacher beliefs as they influence pedagogical practices in online mathematics education course.

Mathematics Education in the Context of this Study

This section explains the ideals and principles associated with mathematics education and it explains how these components influence the overall theory of mathematics education. Prospective teachers typically take courses during their collegiate years learning to teach mathematics and this collegiate experience typically defines mathematics education. Mathematics education in the simplest of terms is the ideals and principles of learning to teach mathematics. The informal process of learning to teach begins long before prospective mathematics teachers start their formal collegiate years in education courses (Ball, 1988). Prospective mathematics teachers spend thirteen years or so in elementary, middle, and high school and during this time students are forming thoughts, ideas and beliefs of teaching mathematics (Anderson, 1984). Through the experience of being a student, some prospective teachers feel they are equipped and ready to master the art of teaching, but those years as a student can indirectly influence the teaching of mathematics, which Bird (2003) describes as the “apprenticeship of observation”; this learning is not grounded in theory and methods and is
strictly experience based; teaching based on past experience can prove harmful and hinder one’s ability to be an effective teacher (Feiman-Nesmer & Buchmann, 1986).

The informal process (by informal I mean the knowledge of teaching gained by observing previous teachers from elementary through high school) sometimes influences the formal mathematics education which takes place in collegiate setting, but teaching is more than just acting like your past teachers, telling students what to do and when to do it. Researchers have recognized that prospective teachers come to college with ideas and ways of thinking (Feiman-Nesmer & Buchmann, 1986). However “apprenticeship of observation” is not formal mathematics education and it influences what prospective teachers learn from courses and field experiences (Bird, 2003). It is also recognized that this type of knowledge acquisition sometimes hinders a teacher’s ability to learn to teach. The term knowledge acquisition is highlighted because some mathematics education programs introduce the ideas of constructivism (by that I mean students that construct knowledge not acquire it), so it seems fair that during the pre-collegiate years students would consider and believe that knowledge is acquired. Prior to mathematics education, I thought that knowledge was acquired. It was not until my education through the mathematics education program that I became aware of constructivism and now I believe that scholars of mathematics education should create opportunities for students to construct their knowledge, not acquire it. The introduction of the ideals of constructivism was profound for me, and that theory also is evidenced in online education and will be discussed later.

Mathematics education is more than just learning how to teach mathematics; mathematics education is a collegiate experience that is grounded in methodology, theory and sound research. Ball (1989) describes mathematics education as the development of methods of teaching and learning which develop beliefs and pedagogical methods as they relate to mathematics. Mathematics education forces the prospective student to apply higher-order thinking in regard to teaching and the preparation of teaching. Prospective mathematics teachers’ commitment is challenged as they are forced to critique their pre-collegiate thoughts and beliefs of mathematics teaching while developing appropriate teacher beliefs grounded in theory, methodology, and research (McDiarmid, 1992).
A Historical Description of Distance Education and the Transformation to Online Learning

This section explains distance education and its migration to online learning, and is divided into three sections 1) the definition of distance learning, 2) the integration of distance education and mathematics education, and 3) distance education focused on online instruction and learning. Online learning is one of the many different forms of distance education and for that reason it is necessary to explain what distance education is (relative to this research) and what impact it has on mathematics education. The literature then focuses on principles of online instruction and learning.

What is Distance Education?

Ally (2004) defines distance education as the use of the Internet to access learning materials: to interact with the content, instructor and other learners; and to obtain support during the learning process, “in order to acquire knowledge, to construct personal meaning, and to grow from the learning experience” (p.5). I again bring attention to the terms “acquire knowledge” and “construct personal meaning” as points for discussion. By combining acquire knowledge and construct personal meaning Ally does not support the ideals of constructivist, who see knowledge as constructed from experiences (Cheung, 2006). Based on Broady-Ortmann (2002), Ally’s definition of distance learning would have been just as profound with the omission of the terms “acquire knowledge”. Filipczak (1995) and Gellman-Danley and Fetzner (1998) state that distance learning will continue to grow as the learner population, technology, and the need for education grows. Distance education has become more popular in primary and secondary education; colleges have begun to offer complete programs allowing individuals to earn undergraduate and graduate degrees through a distance education format. Philips and Yager (1998) state that there are more than 195 accredited universities offering more than one-thousand distance learning courses. The increase in the number of distance learning courses, based on Philips and Yager, is an attempt by society to survive in a competitive world that values the technologically competent citizen. If universities want to compete with other institutions, it has been reported that institutions of higher education must recognize and move toward distance learning (Anakwe and Kessler, 2001; Sherry & Morse, 1995; Smith, Smith & Boone, 2000).

Distance education has many benefits to the individuals, institutions, and entities that
participate. As Potashnik and Capper (1998) explain, universities might use distance education to increase the number of students, while companies could use distance education to increase worker’s knowledge and skills. Individuals may use distance education for personal enhancement, while educators use distance education to offer instruction to students who dwell in remote rural areas. These broad benefits have allowed distance education to become a favorable transport of education in secondary and degree programs (Broady-Ortmann 2002; Rovai 2002).

**Distance Education and Mathematics Education**

Mathematics education courses are typically taught in a traditional face-to-face classroom, which is described by Sherry (1996) as the instructor and the students working together in the same space. Though still existent and widespread, the traditional face-to-face classroom has been influenced by two counterparts of educational delivery: instructional television and interactive technology. In the late 1950s and early 1960s instructional television was, by and large, restricted to studios and live broadcasts where only extraordinary teachers were allowed to conduct classes (Saglik & Ozturk, 1993). Most often the instructors fortunate or capable of using such technology were not the most captivating television talent and struggled to keep the students interested in the subject matter (Cambre, 1991). Fifty years later instructional television has been enhanced by actors, technological advancement, and production companies. Instructional television is no longer an antiquated learning experience. It can be passive, which means pre-produced programs that are distributed and viewed at a later date; it can also be interactive, which means the instructor and student are able to view or hear each other (Lochte, 1993). Instructional television has survived for over fifty years and still has a place and an audience in education. Sherry describes the third transformation as interactive technology and with the emergence of online connectivity and the personal computer, interactive technology has transformed yet again to education at a distance (Gold, 2001).

Sherry (1996) identifies the earliest form of distance learning as a correspondence course in Europe, during which time instructors that were considered experts in the subject, mathematics for instance, were not the best instructors in a distance learning medium. Since this correspondence course, technology has experienced tremendous growth and appearance in the educational arena, especially at the collegiate level (Fowler & Mayes, 1999). One of the reasons for the growth of distance learning is that learning materials can easily be transmitted through the
Internet and the computer monitor (Webster & Hackley, 1997; Miller & Miller, 1999). Due to the large interest and world-wide attention of distance learning, it is important and necessary for educators to embrace technology in the classroom or even accept that some technologies may even replace the classroom (Wang & Chee, 2001).

**Distance Education, Online Instruction, and Learning**

Distance education, simply stated, occurs when students are in one place and teachers, peer learners, or resources are in another. Distance education includes the following list:

- web-based, online, and virtual and e-learning: no face-to-interaction
- satellite: remote learning, limited to no interaction with the instructor
- computer based, distributed, and networked learning: interactive educational activities and software,
- blended learning: combination of online and face-to-face,
- video/audio tape: on interaction with instructor (Ally, 2004; Smith, Smith & Boone, 2000).

This study is focused on an online mathematics education course and therefore attention will be placed specifically on *online/web-based – with no face-to-face instruction*. It is Ally’s view that online learning is born out of online instruction and takes place through the audience of those willing participants choosing its medium of delivery. Table 2.1 describes some definitions of online learning.

Table 2.1

**Definitions of Online Learning**

<table>
<thead>
<tr>
<th>Researcher</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Caliner (1999):</td>
<td>Instruction over the Internet.</td>
</tr>
<tr>
<td>Ally (2004):</td>
<td>The learner is at a distance from the instructor, and the learner uses a computer and the Internet to access the learning materials, and uses these technologies to interact with the instructor and other learners.</td>
</tr>
<tr>
<td>Khan (1997):</td>
<td>Online instruction is an inventive approach for delivering instruction to a remote audience, using the World Wide Web as the medium.</td>
</tr>
</tbody>
</table>

These definitions all share the same sentiment; some are more involved than others, but...
still contain the same principle. Recall that this study is focused on the pedagogical practice and instructional methods of an online mathematics education instructor; therefore presentation and delivery are instrumental in the focus of online learning. Ally defines online learning as the use of the Internet to access learning materials and the instructor is obligated to provide support during the learning process, in order for students to construct knowledge, to construct personal meaning and to grow from the learning experience.

**The Characteristics of Online Education**

It is necessary to paint a holistic picture of online education before being able to appropriately assess how an instructor performs in such an online environment. Therefore, this section details the advantages and disadvantages of online learning and aspects of the community of online education, and by that I mean the classroom community, understanding that a physical classroom is absent in an online course. The literature explains the importance of incorporating effective community building strategies within the instructional methods of online learning.

**Advantages of Online Learning and Instruction**

Researchers have not yet reached a general consensus on online learning; some researchers (Funke, 1998; Stansberry, 2006; Forster, 2006) believe that online education should be an acceptable medium for education, but are not convinced that online education is necessarily beneficial. Online education presents educational opportunities for minorities, high-risk learners, and the handicapped. Not only are opportunities greater for the broad range of people seeking education, online learning also can be an enjoyment for students because it facilitates the sharing of cost, information, and expertise between many learners and educators while providing additional educational opportunities for outlying or disadvantaged locations (Ohler, 1991; Webster & Hackley, 1997). Besides the characterization of online learning explained above, there are clear advantages of online instruction:

- Online learning is not limited by time zones or locations.
- Online learning overcomes the oppression of time and distance and equalizes the opportunity to learn.
- Online learning inherits flexibility in access - from anywhere and usually at anytime and it allows participants to merge time and space.

Additionally, Ally (2004) explains that the Internet affords the learner the ability to have access
to current and relevant learning materials, the ability to communicate is increased, learners are allowed to complete online courses while working on the job or in their own space and online materials can be updated and learners are able to see the changes at once. When learners are able to access materials over the Internet, it is easier for instructors to direct them to appropriate information based on their needs (Ohler, 1991).

**Disadvantages of Online Learning and Instruction**

Just as researchers have identified advantages of online instruction and learning, some researchers have identified some disadvantages associated with online learning. Researchers such as Anakwe and Kessler (2001) believe that students have a more negative than positive attitude towards distance learning. Many students enroll in distance learning environments with some doubts about their ability to learn and be a successful student (Thorpe, 1998).

Research from Sherry and Morse (1995) revealed that unfamiliarity with distance educational technologies represents the largest problem in online learning platforms. Besides the uneasiness of the technology used to administer the course, Anakwe and Kessler (2001) express that some students feel uncomfortable due to fear of the unknown, uncertainty of their ability to learn without interaction with a physical instructor, and lack of confidence in mathematics in a secluded environment. Once students adapt to the concept of online learning, and by adapt I mean getting comfortable with the distance and absence of the physical instructor, the students must focus on learning. Students must also exercise a strong discipline to be successful in an online course. The lack of good study skills may hinder a student’s ability to learn. Therefore, students must be warned that freedom associated with online classes can become overwhelming (Beaudoin, 1990; Harrington, 1999; Taylor & Mohr, 2001).

Despite the disadvantages, Petrides (2002) states that online learning has experienced growth in K-12 schools and in post-secondary education, and the growth is due to cost-effectiveness and the flexibility of the opportunities of access and learning. Lefoe (1998) recognizes the widespread increase in the use of web-based instruction and reports more than fifty-one institutions offer undergraduate and post-graduate online courses. According to Rossett (2002), online learning has many great possibilities and with commitment it could be a value to the educational system. Online learning is more acceptable and prevalent because the learners of today are more non-traditional than earlier generations of learners (Miller & Miller, 1999).
The Classroom Community of a Distance Learning Environment

Understanding the components of online instruction and the use of that understanding in the design of online mathematics education course is considered the catalyst of engagement (Ferdig, 2006), but it is the classroom community that keeps the students engaged and committed throughout the course (Rovai, 2001). Classroom community, that is, classroom as in the traditional face-to-face class, is built on the foundations of spirit, trust, and mutual interdependence among members, connectedness, interactivity, overlapping histories among members, shared values and beliefs, and common expectations (Bellah et al, 1985; McMillian & Chavis, 1986). Classroom community is defined by Rovia (2001) as a feeling that members matter to one another and to the group. The members have duties and obligations to each other and to the school, and they possess shared expectations of the educational needs that are met through their commitment of shared goals. The presence of classroom community makes the classroom experience more enjoyable. Spirit, trust, interaction and learning are at the core of classroom community and interaction is the primary mechanism for the development of classroom community. By interacting with fellow classmates and the instructor, the formation of trust, connections, and defined shared values are developed (Rovia, 2002). Once connection, trust, and values are established, learning can begin; learning is the overarching goal of the community (Owens & Barnes, 1982).

It is now apparent that face-to-face teaching is increasingly being replaced or complemented by learners’ interactions with the learning materials through the Internet via the computer monitor (Wang & Chee 2001). The move of many schools, particularly post-secondary schools, towards distance learning has raised the question of how to foster community where the instructor and the learners are physically separated from each other (Palloff & Pratt, 1999). Notice that in an online environment when discussing classroom community, the word classroom is removed, since the online course is not bound by a physical room. The question of how to foster community in an online environment is worthy of research and discussion prior to thorough study of pedagogical practices and instructional methods can be addressed. When blending classroom community and distance education, Rovia (2002) defines four types of interactions:

a) learner-instructor
b) learner-learner
c) learner-content

d) learner-interface

All of the components above can involve an individual or the entire class. Miller and Miller (1999) explain that learner – instructor and learner-learner focus on interactions among the instructor and the learners. The roles in these interactions are so closely woven that the learner could, in some instances, be the instructor and vise versa. The interactions that create learner-content occur when the learner involves him/her self in the subject matter. The learner constructs meaning from the presentations of the instructor or during the act of constructing personal meaning. It is worth noting that the interactions described above are parallel to the characteristics of constructivism. Though constructivism will be discussed later, this is an opportunity to show how relevant and necessary it is to discuss the characteristics of online learning, and how my thoughts and the research bring the notions of constructivism and online learning together.

The measurement of success in an online environment should include an assessment of the instructor’s ability to create community. Potashnik and Capper (1998) state that the quality of some distance education programs and institutions is perceived to be poor, with their deficiencies often attributable to inadequate planning and a lack of community. Online courses have limitations, for example the absence of facial expression and gestures, which can easily be taken for granted in a traditional face-to-face classroom. There are so many things that happen in a traditional classroom that confirm the existence of classroom community.

Traditional classroom have an obvious signs of classroom community: facial expressions, eye contact, nods of heads, all of which contribute to the classroom community, but these things are absent in an online mathematics education course (Rovia, 2002). While assessing the role of the instructor, it is necessary to understand that the instructor must also deal with the creation or initiation of community. The instructor has to do more than act as if the online course is just like the traditional classroom, because that has been proven unsuccessful (Sherry, 1996). Rovai further explains that for a community to flourish, instructors must be sure that students not only identify with the other students, but students must also feel partial acceptance of the group’s values and goals. If students feel a sense of belonging, their learning experience should be more valuable.

Rovia (2002) explains that learning within the community means that knowledge and
meaning are *actively constructed* within that community, the community enhances the knowledge and understanding, and the community ensures that the learning needs of its members are being satisfied. Again noting the relationship of community and constructivism, the instructor is obligated to establish classroom community, if the instructor believes in constructivism as a learning theory. Because of the limitations, support and interaction with the student is crucial in online learning (Sherry, 1996). Online courses are influenced by the creation of community and the course design and instructors’ ability to teach in an online environment must compensate for the lack of the physical appearance of the instructor and the lack of personal expression which are the limitations of the distance-learning environment. Distance learning differs from the traditional classroom in the isolation and the greater need of self-discipline required of its students (Rovia, 2001 & 2002).

**Characteristics of Online Instruction**

This section focuses on all aspects of instruction in an online environment; it starts by detailing the environment of online learning and instruction. The literature will explain the strategies associated with online instruction and will detail the influence appropriate instruction will have on the learner. Not only are strategies apparent in the online learning course, but it is also necessary to understand the characteristics of an online instructor (Goodyear et al, 2001). The literature then supports the ideas of instructional theories which are informed by learning theories, and not all learning theories, but the theories that researchers have specifically defined as relevant to online instruction.

**The Environment of Online Learning and Instruction**

When online learning was first introduced, instructors were boring and students were uninterested (Gold, 2001) but times have now changed due to the advancement of technology which has given the instructors an opportunity to be more active in the learning process of online learning (Webster & Hackley, 1997). Instruction and the methods of instruction are important and necessary; and the role of the online instructor should not lesson in the online course. It is imperative to understand the role of the instructor in an online environment.

Online learning should be viewed as a vehicle that delivers good, quality, and meaningful instruction; the technology should not be the main focus and should not be viewed as a variable that influences student achievement. The computer and the World Wide Web are instruments in
learning and online learning, just as in the traditional classroom learning is not so much related to the tools, but related to the delivery, the students, and the students’ ability to receive and internalize the subject matter (Rossett, 2002). Whisnant, Sullivan, and Slayton (1992) state that there are three key elements of online learning: the technology, the curriculum, and the instructor. The major difference, as it relates to instruction of online versus traditional course, is that instructors and students must acknowledge that student portfolios, papers, projects, class discussions, postings on class bulletin boards, and teacher-student video conferencing become more important than traditional tests. Students and instructors sometimes find it difficult to adjust to the instructional dimensions of online courses (Sherry & Morse, 1995). Besides the assessment method, online instruction and traditional classroom instruction should have the same objective, educating students.

Online learning is more involved than simply the presentation and delivery of subject matter using the web. The instructor, the learner and the learning process should direct their attention on online learning; the material must also be developed with the learners and learning as the major focus (Rossett, 2002; Ally, 2004). Success in instruction of an online environment is also measured by the instructor’s abilities to build and merge instructional methods into an online environment. Instructors need to become comfortable with the hardware, to understand the flow of data, and to have guided, hands-on practice designing and delivering courseware in a non-threatening environment (Sherry & Morse, 1995). Successful instructors will recognize that the major focus of the course will be the learner as opposed to the technology. Learning is promoted when:

- Learners are engaged in solving real world problems
- Existing knowledge is activated as the foundation for new knowledge
- New knowledge is demonstrated to the learner
- New knowledge is applied to the learner
- New knowledge is integrated into the learner’s world. (Merrill, 1994)

If learning materials are designed correctly, they should engage the learner and encourage the learning experience (Cole & Todd, 2003). Not only will online courses engage the learner and promote learning, Sherry and Morse (1995) maintain that if designed properly, online learning systems can also assist in the determination of the learners’ needs and current level of expertise. Learning is influenced more by the content and instructional strategy than by the type
of technology used to deliver instruction. The students and instructors should collectively take responsibility for the design, evaluation of the course content and the teaching methods used in web-based instruction. If the students and the instructor work together the online environment can be successful. Ally (2004) describes the benefits of the online experience for the instructor:

• Facilitation and instruction are not limited by place and time.
• Learning materials can be updated and the learners can view those changes instantly.
• Instructors have more opportunity to direct learners to appropriate information based on their needs.
• If designed properly, online learning systems can assess learners’ needs and assign learning outcomes.

Characteristics of an Online Instructor

The need for educators (online or traditional) has grown in the United States (Kincheloe 2004), and despite the growth online educators have not received much focus in literature due to the urgency for colleges and universities to implement online learning. The urgency for implementation of online learning has left a gap for inquiry and research; the instructional components of online learning have been overlooked (Gibbons & Wentworth, 2001). The more prominent components for teaching and learning in a distance-learning environment are appropriate delivery methods and an instructor who can concentrate on the learner’s needs (Jones & Knezek 1995; Sherry & Morse 1995).

Oliver and McLoughlin (1999) acknowledge that it is the instructional strategy and not the technology that influences the quality of learning in an online learning environment. Some students may find it difficult to manage an online learning course without the purposeful staging of coursework by the instructor (Beaudoin 1990; Thorpe 1998). Therefore, instructors must:

• Give the students a sense of clarity, purpose, and clear understanding of the objectives.
• Have a comprehensive range of skills, including an understanding of the software, the learner, and an even deeper knowledge of instructional design principles.
• Be obligated to plan and manage classroom details, and develop an awareness of the time demands of distance delivered coursers (Bonk & Dennen, 1999; Oliver & McLoughlin, 1999; Harrington, 1999).
Components of Online Instruction

The literature commonly references the necessary components of online learning: communication, pacing, interactivity, assessment, task, group work, motivation, reflection, and feedback. A section on each topic is given below.

1) Communication

Communication is imperative to the success of an online course. Online instructors must modify their communication skills; that is, communication with students and communication in delivery of course materials. With communication being two-fold, instructor and the communication of assignments, and student and the interaction with other students, the communication must be effective and should initiate a strong and interesting interaction among the students and the instructor. As stated earlier, the focus of this study is the instructor, therefore the communication here specifically relate to the instructor’s ability to effectively communicate with the students. Instructors must clearly describe, in type-written context, all assignments, topic of discussion, and responses to student’s questions. Clearly described assignments offer some relief to students who may feel tension or uneasiness with the online environment (Carr-Chellman & Duschatel, 2000; Beaudoin, 1990; Jones & Knezek, 1995).

Table 2.2 describes communication and the associated instructional goals. Miller and Miller (1999) describe the instructional goal and communication strategy in an online course. In their opinion, there are four primary instructional goals of web-based instruction and for each of those goals the communication strategies are detailed. For communication to be successful, it is their opinion that these strategies are necessary and must be implemented.
Table 2.2

*Instructional Goals and Communication Strategies*

<table>
<thead>
<tr>
<th>Instructional Goal</th>
<th>Communication Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present course content in a sequential and logical manner.</td>
<td>Using an authoring program to control the structure and sequencing of course content (one-to-many, asynchronous)</td>
</tr>
<tr>
<td></td>
<td>Embedding questions in course materials to facilitate elaboration of content (one-to-many, asynchronous)</td>
</tr>
<tr>
<td></td>
<td>Using audio and video conferencing to present content and prescribe learning activities (one-to-many, synchronous)</td>
</tr>
<tr>
<td>Obtain student feedback to insure accuracy of understanding.</td>
<td>Using email to pose questions and solicit answers (one-to-many, asynchronous)</td>
</tr>
<tr>
<td></td>
<td>Creating a bulletin board to pose topics for discussion and to solicit responses that reflect students’ thinking about the subject matter (many-to-many, asynchronous)</td>
</tr>
<tr>
<td></td>
<td>Using audio and video conferencing to discuss content and solicit student responses (one-to-many, synchronous)</td>
</tr>
<tr>
<td>Provide opportunities for students to question the instructor in order to insure accuracy of understanding.</td>
<td>Providing hyperlinks to the instructor’s email address (one-to-one, asynchronous)</td>
</tr>
<tr>
<td></td>
<td>Using instant messaging (one-to one, synchronous)</td>
</tr>
<tr>
<td></td>
<td>Creating a bulletin board to promote questioning and provide instructor responses that are accessible to all students (one-to-many, asynchronous).</td>
</tr>
<tr>
<td>Create opportunities for students to communicate with each other in order to share their understanding of course content</td>
<td>Establish chat rooms that enable on-line discussions of course content (many-to-many, synchronous)</td>
</tr>
<tr>
<td></td>
<td>Creating a bulletin board for this same purpose (many-to-many, asynchronous).</td>
</tr>
</tbody>
</table>

(Miller & Miller, 1999, p.110)

2) **Interactivity**

Communication will generate interaction. Interaction therefore is inevitable if communication is successful. The greatest disadvantage of distance education is largely dependent on the instructor’s skill at maintaining interest and activity. Development of effective interactive learning environments will motivate and engage the learner. Therefore, it is necessary

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2 Asynchronous online learning is when students can access the online materials at anytime, while synchronous online learning allows for real-time interaction between students and the instructor (Ally 2004).
to briefly discuss and recognize interactivity as a component of instruction. Interaction is the engagement in the learning process and involves: 1) interaction among students, 2) interaction between students and instructor, and 3) interaction of students and the instructional materials (Sharp, 2001; Tsao & Yu, 2003).

Pudichery (2003) assessed the interaction involved in an online course and determined that there are two interactions in a web-based course: interactions with other people and interactions with the content, described in Table 2.3. Both interactions in an online environment enable students to construct meaningful and worthwhile knowledge.

Table 2.3

<table>
<thead>
<tr>
<th>Online Course Interactions</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interactions with other people</td>
<td>Teacher-student interactions</td>
</tr>
<tr>
<td>Learner – learner interactions</td>
<td></td>
</tr>
<tr>
<td>Teacher – teacher interactions</td>
<td></td>
</tr>
<tr>
<td>Interactions with content</td>
<td>Learner-content interaction</td>
</tr>
<tr>
<td>Teacher-content interaction</td>
<td></td>
</tr>
<tr>
<td>Content-content interaction</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Implication of Interactions</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Roles of the Instructor</td>
<td>Pedagogical role</td>
</tr>
<tr>
<td>The social role</td>
<td></td>
</tr>
<tr>
<td>The managerial role</td>
<td></td>
</tr>
<tr>
<td>The Roles of the Learner</td>
<td>Knowledge construction</td>
</tr>
<tr>
<td>Self-direction</td>
<td></td>
</tr>
<tr>
<td>Collaboration</td>
<td></td>
</tr>
<tr>
<td>Articulation</td>
<td></td>
</tr>
<tr>
<td>The Roles of the Content</td>
<td>Information to the delivered</td>
</tr>
<tr>
<td>Content design</td>
<td></td>
</tr>
</tbody>
</table>

3) Task

Because a wide variety of students are enrolled in online courses, tasks should:

- Be original and vary in interest,
- Offer opportunities for students to reason,
• Be challenging to help students develop short-term goals,
• Focus on meaningful aspects of learning,
• Support the development and use of effective learning strategies

Tasks that are too challenging can lead to student avoidance of the course or of the assignments and may deter students. Therefore tasks must be strategically and carefully thought through to encourage learning. The most important feature of ‘good tasks’ is that they embody and create the need and opportunity for substantial mathematical reasoning (Ames, 1992; Ball & Bass, 2003; Wilson & Kenney, 2003).

4) Group Work

Group work offers the greatest opportunity for students to interact and build relationships. Therefore, instructors should incorporate cooperative learning which is considered effective group work in the online course. Cooperative learning has been described as a way to empower students of all backgrounds and to reinforce learning skills and concepts. Group work allows the students to learn from each other and induces a collaborative effort, which can be used as another opportunity for classroom interaction in the online environment. Group projects within an online course create an environment where teachers and learners work together to develop knowledge about the variety of topics incorporated in the course (Thompson, 1999; Thorpe, 1998).

5) Pacing

To establish control in an online course, instructors should maintain a pacing schedule, be it internal to the learning institution or one that has been developed by that particular instructor. Pacing generates constraints on what to study and when; these constraints reduce the students’ choices, but provide helpful pressure to achieve a certain amount of study by a certain time. Pacing has two benefits, 1) pacing allows students to build on prior knowledge, and therefore prove to be beneficial in online environments; and 2) pacing creates an opportunity for students to monitor their own mastery of the material. If pacing is incorporated, learning will occur. Work associated with each assignment demands that the student process and understand material prior to building on what has been learned, and prior to being concerned with what to study thereafter (Beaudoin, 1990; Harrington, 1999; Thorpe, 1998).

6) Assessment

An ideal learning environment is one that uses assignments to provide contexts for learning, and
there should be clear and concise instruction for submitting assessment, student work, and any other on-line activities that support skill building. Online learning environments allow students to actively engage in critical dialogue and reflect on information in a way that generates knowledge construction and higher order thinking. Higher order thinking and knowledge construction can be classified as key components in measuring assessment. Assessment is a method to focus on the learner’s needs; assessment can also be used to determine the need for change or modification in the course (Carr-Chellman & Duschatel, 2000; Jonassen, Carr, & Yeuh, 1998; Jones & Knezek, 1995).

Based on a study by Tsao & Yu (2003), future research needs to be done to explain the relativity of the online learning environment. There has been sufficient research to determine the components of online learning but there is still an apparent need to understand the importance of joining components of online learning to successful pedagogical practices in the online learning environment. These researchers developed a summary that provides some useful, current and objective information about the methods and strategies for delivering distance education, and discuss the factors of successful distance learning environment as well as some tips for teaching online. The following pages summarized online learning.

**Active learning environments**

The instructor must:

- Develop instructional materials that encourage and practically force students to respond, to make choices, to perform, to organize, and to think critically about the subject.

**Web-based Teaching**

**Sufficient Training**

The instructor must:

- Be extremely familiar with the technology used in the classroom. Proper training and expertise gives the instructor the ability to merge teaching strategies with the technology used to administer the course; the technology should not be a distraction.
Interactivity

The instructor must:

• Introduce and promote interactivity between teachers and students, between students, between the students and the learning environment, and among the students.

Online Discussion

The instructor must:

• Facilitate online discussion or chats, establish ground rules for discussion, and archive discussions to be used in subsequent lessons.

Six strategies are recommended to facilitate successful online chatting or conversation:

1) Establish a cohesive group by getting acquainted with members of the course, that is, the other students and the instructor. This creates a comfortable environment and community for learners.

2) Share information by assigning collaborative groups, which creates an opportunity to share knowledge.

3) Elaborate on discussions by asking questions to the members of the course.

4) Use online discussion boards to ask questions to prepare for assessments, which give the learners an opportunity to build on prior knowledge.

5) Purposefully frame arguments and probe by asking leading questions, which engages the learner and keeps the learning process interactive.

6) Provide feedback to students through peer critique and instructor critique online. This gives the learner a sense on accomplishment and satisfaction or guidance to success in the class.
Collaboration

The instructor must:

- Recognize that good learning is collaborative and social, it is not competitive and isolated; sharing ideas and responding to other students comments can improve thinking and deepen understanding.
- Carefully design activities and assignments in the course that support the collaboration work of small groups.

Student-Centered Curriculum

The instructor must:

- Recognize the needs of the students and placing those needs at the center of the design process, and take their backgrounds into consideration.
- Personalize the curriculum to allow students to become comfortable with collaborative communication.
- Allow students to find, analyze, organize, evaluate, and internalize new information while keeping their academic and culture backgrounds in perspective.

Time Management

The instructor must:

- Manage time, both the personal time of the students and the overall time of the session or course because one of the biggest challenges for everyone in the web environment is time management. Individuals are responsible for their allocation of time, therefore success is dependent on discipline to stay focused and be aware of time to complete assignments by the due dates.

Diverse Approaches

Courses should employ a wide range of learner differences. A diverse approach is strongly recommended in research studies for delivering
instructions via the web.

Instructors should:
1) Make detailed comments on written assignments, referring to additional sources for supplementary information.
2) Develop strategies for student reinforcement, review, repetition, and remediation.
3) Humanize the course by focusing on students, not the delivery system,
4) Realize that the teacher is no longer at the center of the stage or the deliverer of a fixed body of information; the instructor becomes the facilitator of discovery learning for the students through progressive learning (Sherry, 1996).

**Instructional Beliefs Informed by Learning Theories**

In order for the aforementioned components to be realized, instructors must understand the student’s ability and capability to learn in an online environment. Instructors must prepare the online learning course in anticipation of the needs of the students in advance and provide for the variance of learning behaviors; they must also promote higher–order thinking; the online learning tasks create challenges which allow the learners to link new and old information together (Bonk & Dennen, 1999; Wegner, Holloway, & Garton, 1999). These researchers continue by stating that instructors should respond to and accommodate learners in assisting them to develop their own meaning of the material rather than interpreting the material for them.

Not only is it necessary to understand the instructional characteristics, it is also necessary to understand the learning theories associated with online learning environments. Understanding student’s learning influences the instructor’s beliefs, style of teaching and the choices made in instructional delivery; Duffy and Cunningham (1996) explain the emergence of new learning technologies appear to have coincided with a growing awareness (or lack thereof) and recognition of theories for learning and instruction. Researchers state that there are three main learning theories associated with online courses: *behaviorism* (Zaharias, Vassilopoulou and Poulymenakou, 2001), *social cognition* (Guanawardena 1995; Topper, 2003), and the more
prevalent of the two, constructivism (Huang, 2002; Lainema, 2003). These learning theories inform the respective instructional principle or theory which are explained in the sections to follow.

**Behaviorist Theory.** Behavioral science was once thought as the method for improving education (Rilling, 2000), it was considered the marriage of psychology and education – where it was necessary to understand how students learn. Zaharias, Vassilopoulou and Poulymenakou (2001) define the behaviorist learning principle as learning that occurs through a series of actions based on personal observation and interaction. Behaviorism evolves over time and is influenced by the learning conditions and learning outcomes. The theoretical position of behaviorism depends on the reinforcement used to strengthen or weaken learning. In the case of online mathematics education courses, reinforcements are discussion boards, student portfolios, and posting on class bulletin boards. To support the behaviorist principles, the instructor would see the mind as a “black box”. By “black box” the instructor would see the mind as an empty vessel and the mind uses the reinforcements described above to generate knowledge. This learning theory attempts to improve the capabilities of the mind. The mind would take these reinforcements and internalize and develop understanding.

Zaharias, Vassilopoulou and Poulymenakou (2001) also believe that learning *is not* a process of transmitting information from someone who knows to someone who does not. Instead learning is an active process that happens through direct experience, by engaging in authentic tasks. The instructor that believes this learning theory is considered a behaviorist and the instructor uses obvious behaviors for observation and measurement as indicators of learning. These behaviors then explain the implications for online learning as it relates to behaviorism:

- Learning materials must be sequenced appropriately to promote learning. The sequencing could take the form of simple to complex, known to unknown, and knowledge to application.
- Learners should be told the explicit outcomes of the learning so that they can set expectations and can judge for themselves whether or not they have achieved the outcome of the online lesson.
- Learners must be tested to determine whether or not they have achieved the learning outcome. Assessment should be integrated into the learning sequence to check the learner’s achievement level and to provide appropriate feedback.
• Learners must be provided with feedback so that they can monitor how they are doing and take corrective action if required (Ally, 2004).

Behaviorism used the term “transfer of learning” from the developing behavioral psychology, which means that what is learned in school is somehow carried over to different circumstances and situations (Rilling, 2000). Another theorist thought that schools should educate according to the student individual ability and needs, Thorndike goes further and states that if students are not academically inept they should be taught how to use their natural abilities.

**Socio-Cultural Theory.** Instructors must recognize that interaction and participation levels are instrumental in an online learning course. The interaction and participation levels can be assessed using a social model of learning. This theory is also called social cultural model, social presence theory, or Vygotsky theory. Vygotsky theory supports the cognitive development occurs in two stages: interactions on a social plane, then internalized on a psychological plane (Fielding, 1989). Social theorists are instructors who believe in social theory, and support the idea that 1) students learn by engaging their ideas and experiences with others through discourse, collaboration and communication; 2) there is an apparent degree of learning that is dependent on another learner and the learning environment; and 3) a responsibility to ensure that the online classroom transmits information about facial expressions, direction of looking, posture, dress and nonverbal cues (Guanawardena, 1995; Topper, 2003).

Rio and Alvarez (1995) states that Vygotsky emphasized the importance of the socio-cultural context in which learning takes place and how the context has an impact on what is learned. They speak to Vygotsky’s zone of proximal development (ZPD), which is the difference between assisted and unassisted performance. To summarize, ZPD is the observance of the performance of a novice learner as he or she becomes less dependent upon other regulations and becomes more self-regulated over time. Topper (2003) states that learning occurs when individuals adopt or embrace ideas articulated in discussion. As the novice gains expertise, his or her performance continues to show evidence of previous experiences with social regulation. Under this approach, learning moves from an intra-personal (behaviorism, as described by Zaharias, Vassilopoulou and Poulomenakou, 2001) to an inter- personal plane based on interaction with others, where participation in discourse is a principal activity for learning, and social interaction represents opportunities for learning. With better preparation, clearer guidelines for discussion, and continued vigilance on the part of the instructor, student learning
Constructivist Theory. Researchers (Beaudoin 1990; Oliver and McLoughlin, 1999) state that distance education is developed based on a learner-centered model of education, which is a major component of the constructivism which leads researchers to believe that it holds the greatest sway in online education. Constructivism is defined as giving the learners an opportunity to construct their own knowledge; construction of knowledge is not an optional characteristic of constructivism, it is an obligation.

The research of Lainema (2003) developed a definition of constructivism that is built on the basic forms of interpreting human thinking through the work of Piaget. Piaget believes that cognitive constructions are developed through action. Knowledge is developed from actions that were originally concrete, which later develop through internal mental processes without direct connection to the external action. Constructivists are instructors that support the principles of constructivism, they claim that learners interpret information and the world according to their personal reality, and that they learn by observation, processing, and interpretation, and then personalize the information into personal knowledge (Lefoe, 1998). Chicione (2004) contends that constructivists believe that learners construct their own knowledge by actively participating in the learning process. Constructivism emphasizes the learning experience as:

1) Personal understanding and meaning making.
2) Active and interpretative.
3) Construction of meaning rather than memorizing facts.
4) Reviewing, redefining, and integrating knowledge (Oliver and McLoughlin 1999).

Instructors who follow the ideas of a constructivism value the collaboration, learner self-sufficiency, reflectivity, and active engagement, which seem to support the online learning environment. Based on Oliver and McLoughlin, online environments do not work well if guided instruction is necessary, especially online environments that are completely asynchronous, meaning that learning is not occurring at predetermined or regular intervals.

Table 2.4 depicts the instructional goals associated with the constructivist principles of learning which support that knowledge is not independent of the learner but is internally constructed by the learner as a way of making meaning of experiences. Note that interactions (as previously discussed) have a prominent role as a component of online learning and the literature has just now disclosed that interactions also has a prominent role in constructivist principles. In a
one-to-one interaction where the communication is between the instructor and individual
students, or where the interaction is one-to-many which is between the instructor and a group of
students, the role of the instructor is not to dispense knowledge, but to coach or model meaning-
making (Jonassen, 1999). The instructor is responsible for the conditions of the class and should
arrange the course to foster students’ construction of knowledge. Table 2.4 details the
instructional goal and then describes the associated strategy that would be used to support
constructivism (the interactions are also included).

Table 2.4

<table>
<thead>
<tr>
<th>Instructional Goal</th>
<th>Constructivist Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Present a problem-solving situation in a realistic context.</td>
<td>Select computer-supported collaborative learning software that communicates “real-life” problems in a format and that provides opportunities for students to collaboratively resolve problems (one-to-many and many-to-many, asynchronous).</td>
</tr>
<tr>
<td>Provide opportunities for learners to collaboratively construct knowledge based on multiple perspectives, discussion, and reflection.</td>
<td>Selecting software tools that support collaborative learning/communication (many-to-many, synchronous and asynchronous)</td>
</tr>
<tr>
<td></td>
<td>Using audio and video conferencing to facilitate information sharing and discussion among students (many-to-many, synchronous)</td>
</tr>
<tr>
<td></td>
<td>Employing Internet voice mail to promote immediacy of communication (one-to-many, synchronous)</td>
</tr>
<tr>
<td>Provide opportunities for learners to articulate and revise their thinking in order to insure the accuracy of knowledge construction.</td>
<td>Creating bulletin boards to record students’ responses for later analysis and reflection (many-to-many and one-to-one, asynchronous)</td>
</tr>
<tr>
<td></td>
<td>Using email to pose questions and solicit information (one-to-many, asynchronous)</td>
</tr>
<tr>
<td></td>
<td>Using audio and video conferencing to promote discussion and information-sharing (many-to-many, synchronous)</td>
</tr>
<tr>
<td>Create opportunities for the instructor to coach and facilitate construction of student knowledge.</td>
<td>Using instant messaging to provide immediate motivation (one-to-one, synchronous)</td>
</tr>
<tr>
<td></td>
<td>Using email to analyze learners’ understanding of content and to provide feedback (one-to-one, asynchronous)</td>
</tr>
<tr>
<td></td>
<td>Using audio and video conferencing to model reasoning and problem-solving skills (many-to-many, synchronous).</td>
</tr>
</tbody>
</table>

(Miller & Miller, 1999, p.111)

Lainema (2003) states that constructivism was originally based on the belief that
technology based learning could convey information and understanding more effectively than
teachers of face-to-face classroom. However, Lainema’s research realized that understanding cannot be conveyed; understanding has to be constructed. Huang (2002) conclude that constructivist instructional design incorporates:

- A rich authentic problem-solving environment
- Provides an authentic *versus academic* contexts for learning
- Incorporates a provisions for learner control
- Creates and opportunity for feedback on learner’s understanding through errors
- Learning is embedded in social experience
- Collaborative learning

Cooper (1990) states collectively these strategies: behaviorist, socio-culturalist, and constructivist, allow for online learning to aid in minimizing the issues associated with diverseness in the different learning cultures, styles, and motivations. Table 2.5 summarizes each of the previously described learning theories (Zaharias, Vassilopoulou & Poulymenakou, 2003, p.5).

Table 2.5

*Summary of Learning Theories*

<table>
<thead>
<tr>
<th>Learning Model</th>
<th>Key Views</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objectivist (Behaviorist) Model</td>
<td>There is an objective reality</td>
</tr>
<tr>
<td></td>
<td>The goal of learning is to understand this reality and modify the behavior accordingly</td>
</tr>
<tr>
<td></td>
<td>The goal of teaching is the transmission of knowledge from the expert to the learner</td>
</tr>
<tr>
<td>Constructivist Model</td>
<td>Knowledge is constructed by each learner rather than transmitted</td>
</tr>
<tr>
<td></td>
<td>Constructivist model calls for learner centered instruction</td>
</tr>
<tr>
<td></td>
<td>Learners must have experience with predicting, manipulating objects, posing questions, researching answers, imaging, investigating in order for knowledge to occur</td>
</tr>
</tbody>
</table>
Summary of Learning Theories

<table>
<thead>
<tr>
<th>Learning Model</th>
<th>Key Views</th>
</tr>
</thead>
<tbody>
<tr>
<td>Socio-Cultural Learning Model</td>
<td>It is an extension of and a reaction against some assumptions of constructivism</td>
</tr>
<tr>
<td></td>
<td>There is no external reality (Constructivism and collaboration force the minority to adopt the understanding derived by the majority).</td>
</tr>
<tr>
<td></td>
<td>The social environment and not a reflection of an underlying reality shape this knowledge construction.</td>
</tr>
<tr>
<td></td>
<td>Learners should participate on their own terms; instruction should not deliver a single interpretation of reality nor a culturally biased interpretation of reality</td>
</tr>
<tr>
<td></td>
<td>Social constructivism specifically stresses the importance of feedback</td>
</tr>
</tbody>
</table>

Huang (2002) explains that instructional strategy, subject matter, and instructional theories and other relevant variables are necessary for creating a better learning environment for the online learners. Zaharias, Vassilopoulou and Poulymenakou (2003) explain that when considering the design of web-based applications, an active process should be invoked through direct experience that takes in a web user interface. Some researchers would say that there is no widely accepted learning theory (Huang, 2002); however other researchers would say that constructivism holds the greatest sway (Cobb & Yackel, 1995). Different learning approaches will be appropriate depending on the circumstances (course content, student/learner experience, maturity, skills, and preferences. In assessing pedagogical practices and the instructional methods it was necessary to understand the most common or more recognized learning theories associated with online courses, because the learning theories influence instructional.

During my pilot study, I used a framework titled *A design framework for online learning environments*. The framework involved three learning theories and adequately situates them with instructional methods and for the purpose of my pilot study I only discussed the instructional methods: learning activities, learner support, and content knowledge. Now I would like to include this diagram in its entirety because it takes behaviorism, cognitive psychology and constructivism and the results of this study determined that constructivism is the most suitable for online learning courses (Hung, 2001).
Because online environments are more subjective to principles of constructivism, I take this opportunity to elaborate more on the approaches to instruction based on constructivism as a learning theory discussed in researching this framework (Villalba & Romiskzoski, 2001):

- **The overall assumption:**
  - Learning is understood as interpretative and emergent (Cobb & Yackel, 1995) and under the control of the learner
  - Knowledge is negotiated meaning and is nestled with reality and should be constructed by group work

- **Basic instructional approaches:**
  - The goals should be negotiated through instructor – learner interactions
  - The learner is the center of the design activity
  - Assessment is designed around real-world problems and promotes self evaluation and reflection
Online approaches:

- Use of discussion forums and chat
- Email among the learners
- Group projects
- Media use
- Provision for social activities on the net

Cooper (1990) states that behaviorist, socio-culturalist, and constructivist theories have contributed in different ways to the design of online materials. As also noted by the works of Huang (2002) and Lefoe (1998), the consideration of learning theories is essential to the design of online courses because learning theories introduce the ideas of authentic real-world problems. Real-world problems are proven beneficial because they are interesting and meaningful to the students which then keeps the students engaged (Ferdig, 2006).

Instructor Beliefs, Pedagogical Practices and the Impact on Online Instruction

Thus far I have presented research on mathematics education and its integration with the online learning environment. I have also disclosed aspects of online learning and the need to establish community. I have not yet described teaching, more specifically, instructor beliefs and the implications they have on the pedagogical practices in an online mathematics education course. Before relating pedagogical practice and online mathematics education it is necessary to describe teacher beliefs and explain how those beliefs inform pedagogical practices.

Instructor Beliefs

The idea of ‘teacher beliefs’ emerged in the early 1900s and was described by Dewey (1933) as “something beyond itself by which its value is tested; it makes assertions about some matter of fact or some principle of law” (p. 6). Over the last seventy years there have been several definitions of all of which confirm that there is no globally accepted definition of the term teacher beliefs. Rokeach (1968) defines instructor beliefs as a conscious or unconscious mental process informed by what a person says or does, and Artzt and Armour-Thomas (2002) define beliefs as personalized assumptions relative to a specific subject. Though there have been various definitions of beliefs the definitions share the similar concepts and those concepts lead to similarities that should be discussed further. Those concepts are family values or familial influences, truth, behaviors and actions, and the conscious vs. unconscious mental processes all
associated with beliefs. Table 2.6 describes each of these concepts as key elements of instructor beliefs (Fennema & Franke, 1992; Thompson, 1992).

Table 2.6
Characteristics of Instructor Beliefs

<table>
<thead>
<tr>
<th>Characteristics of Instructor Beliefs</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Family Influences</td>
<td>The belief systems are established from parents and other significant people such as other relatives, neighbors, teachers and friends. Beliefs are furthered developed through school experiences, informal observation, and day-to-day interactions (Lasley, 1980; Lortie, 1975; Pajares, 1992).</td>
</tr>
<tr>
<td>The Reality of Beliefs</td>
<td>Beliefs are accepted as a reality to the individual who holds that particular belief and when a person believes something, that person holds it as truth (Harvey, 1986).</td>
</tr>
<tr>
<td>Conscious and Unconscious Processes</td>
<td>Since beliefs become the abstract concept of truth, instructors are not always aware of the beliefs they hold. Instructors are sometimes not aware of their beliefs until the instructor reflects or someone else reflects on the instructor. The awareness or lack of awareness is the conscious and unconscious mental process of beliefs (Garrahay, 2003).</td>
</tr>
<tr>
<td>Behaviors and Actions</td>
<td>Because a person’s beliefs are reality, those beliefs form the behaviors and actions of those individuals, therefore lending credence to the idea that instructor’s actions are built on beliefs. Teacher’s beliefs influence their thought process which then determines the behaviors and actions of students (Lewis, 1990; Ashton, 1996).</td>
</tr>
</tbody>
</table>

The mental process of beliefs began at the point of birth; family experiences and childhood relationships cultivate beliefs. Beliefs become truth and because of that truth conscious and unconscious actions become evident. Behaviors and actions spawn from teacher beliefs are then evidenced in an online course by knowledge construction. Because behaviors and actions influence instructor’s activities within an online course and those activities lead to knowledge construction, it is sometimes difficult to separate the notions of beliefs and knowledge construction activities or principles (Thompson, 1992). Because beliefs are built on long standing life experiences (including family and reality), beliefs are considered much...
stronger than knowledge construction. The ideas of knowledge construction are developed through an educational experience, not necessarily a life long lesson but one that is taught through college (Pajares, 1992).

There is an apparent relationship between instructor beliefs and instructor knowledge; therefore it is necessary to understand how these concepts inform instructional practices. Instructors that recognize their beliefs and are free to teach to those beliefs typically have more control over their thinking process and their actions within the course, thereby making more informed decisions in their instructional strategies (Wheatley, 1992). In understanding beliefs and the impact they have on the teaching style of the instructor, it is necessary to explain teaching by examining pedagogical practice within an online course.

**Pedagogical Knowledge**

Simon (2006) defines pedagogy as a process through which teachers are encouraged to know, to form a particular way of ordering what teachers know, making sense of what teachers know, and sharing what teachers know. In other words, pedagogy is a set of rules that prescribe how learners can achieve a class of learning objectives in a certain context or knowledge domain in the most effective way (Segall 2004). Pedagogical knowledge involves two things: the first component of pedagogical knowledge is that understanding begins with what is already inside the learner’s head. All students come to college with prior ideas, and the first pedagogical challenge is to bring what is inside, out. Instructors should want students to say what they know with great precision and rigor. The second process is once the knowledge is out, teachers then should work together with the students to enhance that knowledge or refine the knowledge base. This classification could include testing, shifting, rearranging, reconstructing, and repairing that knowledge. Once the external knowledge is manipulated, enhanced, or re-evaluated, it should be put back in and shared with other learners (Shulman, 1987b).

Pedagogy is bound by rules and is accompanied by values. Teachers and students are expected to act according to these values, pedagogy requires instructors to make decisions continuously, and it also means choosing between competing alternatives in order to arrive at a certain result (Koper & Olivier, 2004). As discussed earlier, mathematics education, simply stated, is learning to teach mathematics. By learning to teach, a prospective teacher is actually gaining pedagogical knowledge (Ball, 1990b). Kincheloe (2004) states that there are many complexities of good teaching, one of these is identifying individual and collective needs of the
students, and then to connect to and establish a pedagogical strategy. If practicing teachers have been effectively and appropriately prepared, research supports that their learning community will be productive. Smith, Smith, and Boone (2000) express that properly prepared practicing teachers will experience:

- an overall increase in student participation,
- an improved ability to apply the material of the course in new contexts,
- express independent ideas relating to the material,
- improved access for the student and the instructor,
- improved ability to make connections between diverse ideas and information,

The characteristics listed above define components of pedagogy, which Segall (2004) classifies as a domain specific for teachers.

The oldest problem of pedagogy is the appearance of learning— that is, illusory understanding. Illusory understanding is defined as when a person appears to know something that he or she really does not know. Teachers must be able to realize when the students ‘don’t get it’. If the teachers too often misread the student’s understanding, the student will ultimately suffer. To begin to understand and minimize the likelihood of illusory understanding, it is suggested to possibly teach learners to engage in active thinking about what they know and how they know it and create conditions where they can discuss what they know with others (Shulman, 1987a).

Teacher educators have looked to research on teaching for guidance in designing programs for teachers. But knowing what good teachers do, how they think, or what they know is not the same as knowing how teachers learn to think and act in particular ways and what contributed to their learning (Feiman-Nemser & Remillard, 1996). Researchers, policymakers, and teacher educators are beginning to recognize that understanding more about who teachers are as learners, what they need to know, and how they learn their craft can help in clarifying the role of formal teacher education in learning to teach. Simply stated, teacher success depends on knowledge and skills (Ball, 1988; Buchmann, 1984; Clark 1988).

**Pedagogical Content Knowledge**

There is an apparent division of labor whereby scholars in the discipline provide content while teachers provide pedagogy (Segall, 2004). Though there is a distinctive division in content and pedagogy, there is also a thin and sometimes seamless boundary in merging the two into
pedagogical content knowledge. Veal and MaKinster (1999) state that an examination of this idea reveals that teachers should in fact relate to their subject matter knowledge, if not how can they teach? Well the truth of the matter is practically anyone can teach, but we as mathematics educators are not interested in just a person, a body standing before the classroom; teacher educators, researchers, and policy makers desire teachers that share compassion and sincere relationship to mathematics and mathematics education (Ball, 1990a).

Because there is a thin boundary between pedagogical knowledge and content knowledge, it is necessary to take both views, separately and collectively. The earlier stated definition of Veal and MaKinster (1999), states that pedagogical content knowledge is the manner in which teachers relate to their subject matter knowledge in the school context. More specifically, mathematics teacher education prepares the teacher for being able to diagnose the student’s readiness to learn, to monitor a student’s progress toward objectives sought, to recognize and discover a student’s learning difficulties, to stimulate and challenge students’ further efforts, and to evaluate the quality of a student’s learning (Beaudoin, 1990).

Shulman (1986) integrates content and pedagogical knowledge to explain pedagogical content knowledge. In this research, Shulman simply describes pedagogical content knowledge as a process through which a teacher should combine content and pedagogy to make learning powerful and meaningful. This knowledge consists of useful forms of representations of mathematics such as analogies, illustrations, examples, explanations, demonstrations, learning cues, and drills. Chen and Ennis (1995) state that it has been realized that transforming subject content knowledge into pedagogical content knowledge is a critical step toward effective teaching. Instructors need more than strong mathematics content knowledge to be able to enact the vision of teaching. They also need knowledge of students, curriculum, learning theory, and pedagogy.
Instructor Beliefs, Pedagogical Practices, Online Learning, and Instruction

Foss and Kleinsasser (1996) explain that content knowledge and pedagogical knowledge involve knowing the content of the subject and being aware of the means by which the content is taught. Knowing the content means that the instructor must realize that the subject matter (mathematics) is seen as a fixed collection of facts, concepts, and skills that must be learned before it can be applied (Grossman, 1987). Applying the knowledge involves pedagogy. Teaching is the transformation of content into pedagogical forms (Segall, 2004). Historically, knowledge bases of teacher education have focused on the content knowledge of the teacher; and more recently teacher education has shifted its focus primarily to pedagogy (Ball, 1990a).

Thus far I have detailed pedagogy and pedagogical content knowledge as it relates to the traditional face-to-face classroom. Research from previous studies has disclosed that courses which were designed for a traditional classroom setting will have to be re-designed for distance learning students (Beaudoin, 1990); by that I mean, applying teacher beliefs and taking previous pedagogical practices and modify them to conform to online mathematics education course. The need for re-design can be attributed to students, curriculum, learning theory, and pedagogy (Chen & Ennis, 1995). There is a great deal of research on distance learning which focuses on the technological aspect and the student, but unfortunately the pedagogical practices and instructional methods have sometimes been overlooked (Hara & King, 1999). Research does not
explicitly detail the implications of traditional pedagogical knowledge in an online mathematics education course, therefore leaving room for inquiry. Beaudoin does however describe the goals and expected abilities of an effective online instructor:

- To diagnose the student’s readiness to learn,
- To monitor a student’s progress toward objectives sought,
- To recognize and discover a student’s learning difficulties,
- To stimulate and challenge students’ further efforts,
- To evaluate the quality of a student’s learning, and
- To assign a grade to estimate learning outcomes.

The online environment creates a great responsibility for instructors. Instructors must compensate for the limitations, that is, lack of interaction with students and the instructor, lack of classroom community, and lack of communication (Anakwe & Kessler, 2001) in an online course. Not only are online courses driven by the presence of community, but they are also driven by ‘pedagogical models’ that capture the teachers’ beliefs about good teaching and learning (Rovai, 2001). Kincheloe (2004) states that there is no concrete perspective on good teaching, nothing that explains what subject matter to teach, the proper way to develop a curriculum, the correct understanding of students, and the right way to teach. However Howell, Williams and Lindsay (2003) detail the current needs and trends in education:

- Personalized instruction: learner-centered, non-linear, and self-directed.
- The distinction between face-to-face and distance education is disappearing through the use of online courses. Blended courses, which include distance learning platforms and the face-to-face course will be dominant in the future.
- Lifelong learning is necessary and it incorporated networked learning
- Academic emphasis is shifting from course completion to competency attainment.
- Faculty roles in the traditional term are moving toward specialized roles.
- Faculty members demand decreased workloads, especially while working with learning management systems or online collaborative and conference environments.

Cohen (1988) states that prospective teachers believe that teaching is a process of passing knowledge from teacher to student and that learning involves absorbing information and practicing skills. There is a difference between what it means to know and understand something yourself and what it takes to help someone else know and understand it (Shulman, 1987). Several
researchers have rekindled the discussion about the importance of teachers’ content knowledge in learning to teach mathematics because mathematics teacher education should produce teachers who have recognized their beliefs and have obtained formal knowledge that can be applied in the mathematical arena. Research on pedagogy has focused on the application of general pedagogical practices in the classroom isolated from the distinction of the course delivery medium (Veal & MaKinster, 1999).

This research focuses on the delivery medium of an online learning environment. How would the pedagogical practices and instructor beliefs impact the instructional practices of an online mathematics education course? Barab, MaKinster, Moore, and Cunningham (2001) state that web-based education is based on learning and community, as opposed to guided instruction, which is most often found in the traditional classroom setting. The web-based experience should change from that of the traditional experience, to education that supports a culture of sharing, and provide sustained support for teachers as they evaluate both their beliefs and practice. Feiman-Nesmer & Remillard (1996) explain that conventional teacher education reflects a view of learning to teach as a two-step process of knowledge acquisition and application transfer. Knowledge acquisition is the process of learning the content – content knowledge and application transfer is the process of teaching, teaching styles, and delivery – pedagogical knowledge. These views are different from the constructivist principles that are necessary in an online learning course (Huang, 2002); for that reason Huang states that distance education requires a new pedagogy that is built on a unique relationship between the instructor and the learners, where the instructor creates opportunities for the learners to construct knowledge.

Pudichery (2003) believes that online courses require a different awareness of pedagogy. The construction of meaningful and worthwhile knowledge occurs through interactions, communications, and collaborations among educators, learners, and content through the Web and other communication technologies, which contribute to the pedagogy of an online course. Recall that the main components of online learning are:

- Web technology together with communication technologies
- Web-based interactions and their implication of the teacher and the content
- Construction of knowledge

Lantz and Brage (2004) studied a web-based information literacy (librarian) course taking into account the student’s perspective which is completely different from the focus of my
study, that is, librarian courses verses mathematics education; however the concluding remarks were interesting and could offer insight to my study. Figure 2.3 takes into account the contributors of online instruction thereby supporting research previously discussed on online instruction.

![Diagram of contributors to online instruction](image)

Figure 2.3 Contributors to Online Instruction (Lantz & Brage, 2004).

Understanding pedagogy and its implications in an online environment has gone lacking since a great deal of attention has been on the students and their learning; there has not been extensive research on the instructor and instruction (De Simone, 2006). This void has provided opportunity for inquiry. There are a wide range of factors that influence instruction of an online course, therefore instructors are charged with the management of the educational process by being good teachers who help students learn to learn, ask the appropriate questions, and share the responsibility of the learning. Table 2.7 describes components of web-based pedagogy as presented by various researchers.
Table 2.7
Web-Based Pedagogy

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student learning styles</td>
<td>Instructors must focus on the needs and strengths of students in order to meet the diversity of learning styles. As learning becomes personalized, it will be necessary for students to have appropriate skills and tools to engage and participate in the learning process (Gergen, 1995).</td>
</tr>
<tr>
<td>Collaborative learning environments</td>
<td>Instructors must support learning environments that allow learners to collaborate, reflect, and to articulate. Learners should then be able to perform at higher levels (Doolittle, 1999).</td>
</tr>
<tr>
<td>Interactivity</td>
<td>Instructors are responsible for introducing an interactive learning experience. The student is responsible for becoming an active participant rather than a passive recipient of learning (Tsao &amp; Yu, 2003).</td>
</tr>
<tr>
<td>Motivation</td>
<td>Instructors are responsible for introducing a course that is engaging and motivating. Student’s motivation can affect task, the community of the course, the students’ perception of the instructor, and the overall student experience (Ferdig, 2006).</td>
</tr>
<tr>
<td>Context</td>
<td>Instructors must keep the course in context; this is necessary to determine how knowledge is organized, represented, negotiated, used and how new information is constructed and connected to prior knowledge (Bonk &amp; Reynolds, 1997).</td>
</tr>
<tr>
<td>Diversity</td>
<td>Instructors must maintain diversity. Online learning environments should support multiple learners while incorporating various kinds of activities to support the different types of learners. Diversity gives the opportunity for learners to become focused and motivated (Lainema, 2003).</td>
</tr>
</tbody>
</table>

**Theoretical Framework**

This section describes relevant theoretical frameworks that have been used by previous researchers to analyze and understand teacher beliefs and how those beliefs influence their pedagogical practices. Frameworks satisfy the needs of the study which limits confusion to support explicit decisions about the data (Jacob, 1988; Selfe, 1990). Having a framework goes beyond just identifying problems with current or existing studies; frameworks offer new ways of looking at and perceiving phenomena and offer information to base solid decision making (Cobb et al., 2003).
In an effort to conceptualize how instructor beliefs influence successful pedagogical practices, Turner-Bisset (1999) presented a framework titled Knowledge Bases for Teaching. This framework combined Shulman’s Categories of the Knowledge Base (Shulman, 1987b) and Dunne and Harvard’s (1990) Dimensions of Teaching to analyze teacher education and uses that knowledge to develop the essential components of pedagogical reasoning. This framework takes the actions of an instructor and separates them in two categories of understanding: knowledge and beliefs.

One of the main goals of this framework is to determine ‘how’ an instructor understands the subject matter, and how that knowledge is delivered or administered through pedagogical practices that promote higher-order thinking. In comparing these categories content knowledge is more superficial than beliefs, content knowledge can be as simple as the memorization of mathematical facts and skills. Beliefs however are much deeper and are more evident in experienced teachers (Rimm-Kaufman & Sawyer, 2004) and beliefs refer to the idea of knowing at the conceptual and problem-solving level. Table 2.8 (Turner-Bisset, 1999, p.43) details the results after combining Shulman’s and Dunne and Harvard’s works, then immediately following the table are short descriptive narratives to define each of the components.

Table 2.8

<table>
<thead>
<tr>
<th>Knowledge Base</th>
<th>Codes</th>
<th>Knowledge Base</th>
<th>Codes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substantive Subject Knowledge</td>
<td>SUB</td>
<td>Knowledge of Learners: Cognitive</td>
<td>L-COG</td>
</tr>
<tr>
<td>Syntactic Subject Knowledge</td>
<td>SYN</td>
<td>Knowledge of Learners: Empirical</td>
<td>L-EMP</td>
</tr>
<tr>
<td>Beliefs about the Subject</td>
<td>BEL</td>
<td>Knowledge of Self</td>
<td>SELF</td>
</tr>
<tr>
<td>Curriculum Knowledge</td>
<td>CUR</td>
<td>Knowledge of Educational Context</td>
<td>CON</td>
</tr>
<tr>
<td>General Pedagogical Knowledge</td>
<td>GPK</td>
<td>Knowledge of Educational Ends</td>
<td>ENDS</td>
</tr>
<tr>
<td>Knowledge /models of Teaching</td>
<td>MOD</td>
<td>Pedagogical Content Knowledge</td>
<td>PCK</td>
</tr>
</tbody>
</table>

Substantive Knowledge is described as the facts and concepts of a particular discipline (in small bits or more grouped together) for the emergence of knowledge.

Syntactic Subject Knowledge represents the methods by which knowledge has been generated and constructed and because knowledge is built from prior knowledge some researchers may use imagination to further construct an understanding of the past.

Beliefs about the Subject represents what instructors feel is important to know about the subject.
matter and what is ‘important to know’ is influential in what teachers teach and how they teach it (Grossman, 1987). Beliefs about mathematics are just as important as the facts, concepts, and method and therefore require that beliefs be examined separately.

Curriculum Knowledge goes further than the materials of the course. Instructors draw on their knowledge of a particular discipline to present the subject to the students. There is a tendency for instructors who are not particularly confident in their subject matter knowledge (mathematics) to rely heavily on textbooks and other resources without a true assessment to determine if that resource is suitable for the course.

General Pedagogical Knowledge is knowledge of teaching obtained through a collegiate experience. Observation of the instructor actions in the classroom will typically lend more credence in determining their actual practice as opposed to simply interviewing an instructor to find out what they think or verbalize they do; this component supports the notion that instructors may not be able to articulate what they do while teaching a course.

Knowledge/Models of Teaching shares the same sentiment as teacher beliefs. Knowledge gained through a collegiate education further defines the teacher’s perceptions of teaching knowledge or teaching models (pedagogy). The component is similar to beliefs because it can dictate the actions taken within the course.

Knowledge of Learners – Cognitive is similar in principle and concept to child development, which says that children respond well to structured activities when trying to construct knowledge. This component also shares the concepts of adaptation and differentiation which means that activities should respond to the student needs by using teaching strategies that adapt to the various learners in the course.

Knowledge of Learners – Empirical is a more in-depth method of describing the characteristics of the learner. This component supports the necessity for the instructor to understand the learners within the course; this includes the social skills and backgrounds, current events that may affect students’ success within the course, and the basic relationship of fellow students and the instructor.

Knowledge of Self presents the idea that teachers are regular people before they become teachers and their life experience is considered a ‘lesson’ and understanding one self is instrumental in being able to teach. Instructors must understand the biases they bring to the teaching experience and not understanding, acknowledging, and accepting those biases can limit the success of the
Knowledge of Educational Contexts is the knowledge of the school, the university, the city and state, which represent the setting for the course. This variable impacts the teacher’s ability to teach because depending on the constraints associated with these elements, the potential for external intrusion is possible.

Knowledge of Educational Ends describes that teaching has a purpose, be it for students to further their education, career advancement, or to meet the demands of a current job; whatever the reason teaching has an educational end. Because education has a purpose instructors should have a moral responsibility to ensure or present the best learning environment for the educational ends to be met.

Pedagogical Content Knowledge is the combination of content and pedagogical knowledge. Shulman (1986, 1987a) describes the pedagogical content knowledge as powerful and meaning knowledge. This knowledge level gives the instructor an opportunity to expand beyond memorization of formulas and algorithms to instruction that can take multiple representations, offers in-depth understanding, and provision of thorough explanations. Shulman describes pedagogical content knowledge as the combination of content and pedagogical knowledge to present a powerful and meaningful learning experience.

This framework was used to explain instructor beliefs and their relation to pedagogical content knowledge. This framework takes the actions of an instructor and separates them in two categories of understanding: knowledge and beliefs. Samuelowicz and Bain (2001) presented a framework that focuses on belief dimensions and teaching-centered orientations. This framework supports that it is necessary to understand the role of a teacher’s personal beliefs and teaching in a teaching-centered environment. Kane, Sandretto, and Heath (2002) referenced this framework as they assessed beliefs academics have in regards to teaching.

This study was designed to focus on belief dimensions and learning-centered orientations which are captured by a framework presented by Samuelowicz and Bain (2001). At the deeper levels of knowing, the instructor has moved passed the initial principles of content knowledge, that is, simply knowing algorithms, rote mathematics, and memorization; instead this framework brings learning and beliefs together and embodies the need for reasoning and active learning principles, which influences higher-order thinking (Cobb & Yackel, 1995). This identifies the slight difference in Samuelowicz and Bain’s framework and Turner-Bisset (1999), Samuelowicz
and Bain focus on beliefs and instruction and Turner-Bisset is more focused on knowledge and beliefs.

Samuelowicz & Bain (2001) presents a framework where instruction should be organized to facilitate knowledge growth or enhancement for the students, relating specifically to students’ current understanding and the potential for understanding. Fennema and Franke (1992) state that instructor knowledge is built on instructor’s beliefs, their ability to understand mathematics, and their ability to understand the students. Table 2.9 shows that there are nine belief dimensions and four learning-centered orientations. The table below shows that the cross-section of learning-centered orientations and belief dimensions produces an expected outcome or an occurrence when these two paradigms meet. There is also a single letter which represents that this particular association should be either learning–centered (‘L’) or teaching – centered (‘T’) or a combination there of. Immediately following the table are short descriptive narratives that define each of the belief dimensions and the associated variation of outcomes.

Table 2.9
Learning – Centered Orientations and Belief Dimensions

<table>
<thead>
<tr>
<th>Belief Dimensions</th>
<th>Learning – Centered Orientations</th>
<th>Negotiating Understanding</th>
<th>Encouraging Knowledge Creation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desired learning Outcomes</td>
<td>Helping Students Develop Expertise</td>
<td>Preventing Misunderstandings</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Change in ways of thinking</td>
<td>Change in ways of thinking</td>
<td>Change in ways of thinking</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Expected use of knowledge</td>
<td>Interpretation of reality</td>
<td>Interpretation of reality</td>
<td>Interpretation of reality</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Responsibility for organizing or transforming knowledge</td>
<td>Student &amp; Teacher</td>
<td>Students</td>
<td>Students</td>
</tr>
<tr>
<td>Nature of knowledge</td>
<td>Personalized</td>
<td>Personalized</td>
<td>Personalized</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Students’ Existing Conceptions</td>
<td>Not taken into account</td>
<td>Used to prevent common mistakes</td>
<td>Used as basis for conceptual change</td>
</tr>
<tr>
<td></td>
<td>T</td>
<td>L/t</td>
<td>L</td>
</tr>
</tbody>
</table>

54
Table 2.9 – continued.

**Learning – Centered Orientations and Belief Dimensions**

<table>
<thead>
<tr>
<th>Belief Dimensions</th>
<th>Learning – Centered Orientations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Helping Students Develop Expertise</td>
</tr>
<tr>
<td>Teacher-Student Interactions</td>
<td>Two-way to negotiate meaning L</td>
</tr>
<tr>
<td>Control of Content</td>
<td>Teacher T</td>
</tr>
<tr>
<td>Professional Development</td>
<td>Stressed L</td>
</tr>
<tr>
<td>Interest and Motivation</td>
<td>Students’ L</td>
</tr>
<tr>
<td><strong>T = Teaching Centered</strong></td>
<td><strong>T/l = Teaching Centered but with aspects of learning emphasis</strong></td>
</tr>
<tr>
<td><strong>L = Learning Centered</strong></td>
<td><strong>L/t = Learning Centered but with aspects of teaching emphasis</strong></td>
</tr>
</tbody>
</table>

**Desired Learning Outcome** is described as retention of information, reproductive understanding, or changes in the ways students think.

**Expected Use of Knowledge** can be apparent within the subject, within the subject but for future use, or an interpretation is required of the student to associate with that student’s reality.

**Responsibility for Organizing or Transforming Knowledge** means that either the instructor is fully responsible, the instructor explains how knowledge can be organized, the students (with some instructor involvement) are responsible, or the students are fully responsible.

**Nature of Knowledge** is either constructed or personalized for each student.

**Students’ Existing Conceptions** are expected to fall into the spectrum of *not taken to account* in the learning process or they are used to *negotiate meaning*.

**Teacher – Student Interactions** are either one-way (teacher to student), two-way (to maintain interest), two-way (check/clarify student’s understanding), or two-way (to negotiate meaning).

**Control of Content** means there is an expectation that control of the content will rest with either the instructor or the student.

**Professional Development** is considered as the instructor focused on student development and this framework expects that either the student will be stressed or that the instructor should not to be stressed.

**Interest and Motivation** captures the effort of the instructor or the students to initiate interest and motivation (Samuelowicz & Bain, 2001).

This work has been referenced and used by other researchers. The remaining portion of
this section briefly details studies that have referenced the framework presented by Samuelowicz and Bain (2001). Kane, Sandretto, and Heath (2002) reviewed fifty studies in an effort to review teaching beliefs and practices of university academics. These researchers state that research that focuses only on what instructors say (as opposed to what they observe instructors actually doing) could fall short and only represent half the story. The Samuelowicz and Bain study was one of the fifty studies that was used. Kane, Sandretto, and Heath found that Samuelowicz and Bain’s work explained teacher practices by examining theories of action.

Roberts (2003) also referenced the work of Samuelowicz and Bain (2001) as he studied the most effective use of the web in teaching. Unlike my study, this study uses the web as a tool in the classroom; my study presents the web as the medium of delivery. This study used mixed methodology. Roberts surveyed for two weeks and received two hundred and fifty-six responses, and then interviewed select number of staff. The data was analyzed by the approaches used by Samuelowicz and Bain, creating a theory by multiple comparisons. A model emerged from this study and it was intended to present concepts for teaching using on the web.

**Researcher’s View**

Offering a mathematics education courses through an online medium can be an overwhelming task for many reasons, such as dealing with the administration, university, politics, students, and the instructors. This study specifically addresses the implications of beliefs and decisions through learning-centered orientations as they influence the pedagogical practices on an online instructor. Since this study speaks to mathematics education it was necessary for me to define mathematics education as it will be viewed for the mission of this study. Mathematics education is the development of methods of teaching and learning; it also informs prospective teachers of the appropriate characteristics of learning and the necessary and viable aspects of teaching (Ball, 1989).

The study and the literature purposefully focus on the methods of the instructor, more so than the characteristics of student’s learning patterns. This study also intentionally focuses on describing two meaningful terms in mathematics education – beliefs and pedagogy. Pedagogy, as described by Simon (2006) and Shulman (1987a) is the act of identifying what teachers know, the organization of that knowledge, making sense of that knowledge, and ultimately sharing that knowledge; and beliefs are described as the instructors conceptions of what they ‘know’ and ‘how’ they have come to know it (Grossman, 1987). Beliefs are strong and deeply connected to
an instructor’s core concepts and principles of teaching which conceptualizes what instructor views as reality. Instructor beliefs about mathematics are settled in his/her beliefs about mathematics teaching and learning (Ernest, 1988; Thompson, 1992).

This study is concentrated on the online learning environment where researchers (Rovia, 2002; Ally, 2004; Ohler, 1991) feel an in-depth knowledge of the mathematics is necessary. Therefore the discussion of pedagogy also describes pedagogical knowledge and pedagogical content knowledge, the integration of content and pedagogical knowledge (Shulman, 1986). For the sake of simplicity the term pedagogical practice was used.

**Research Questions**

Mathematics education teaches prospective teachers how to teach - *pedagogy*, and how to teach mathematics - *pedagogical content knowledge*. However pedagogical content knowledge has not received an abundance of attention as in research related to online mathematics education courses. Mishra and Koehler (2006) have discussed technological pedagogical content knowledge, which speaks to using technology like calculators and Microsoft Office, in the classroom, but did not speak to the characteristics of pedagogy relative to an online environment. Another researcher (Ball, 1989) does speak to pedagogical knowledge of mathematics education, but does not speak to pedagogical content knowledge of online environment. The online environment emerged so quickly that educational institutions, due to the urgency to implement online courses, left online instructors to rely on pedagogical practices that were intended for the traditional face-to-face classroom (Pudichery, 2003).

This research study has been designed to understand how pedagogical practices can be used in mathematics education to transform teacher knowledge, beliefs, and thinking in an online environment. Argyris and Schon (1974) question the authenticity of beliefs by stating that beliefs taught in school are not always exhibited within the course, but beliefs that are to the core of the instructor’s knowledge and beliefs that come from a more experienced teacher are not easily swayed. Therefore it would be interesting, as the literature supports (Kinach, 2002), to evaluate the beliefs of an instructor to determine how those beliefs influence his or her instructional practices. This research takes that question and applies it to an online course to determine the impact of instructor beliefs.

These oversights and under-researched areas leave room for future study and support the motivation for this study. The gaps in the literature regarding pedagogy and beliefs, and their
implications on the instructional methods of an online mathematics education course have not yet been disclosed and therefore prove worthy of research. To research these educational characteristics when focused on belief dimensions and learning-centered orientations, I plan to address the following primary research question:

What model can be produced when examining an online mathematics education course using a framework focused on instructor belief dimensions and learning-centered orientations?

To further explain the model, it will be necessary for me to address two secondary questions:

1. What are the learning-centered orientations of the instructor’s online teaching practices?
2. How do the instructor’s belief dimensions influence his (her) on-line teaching practices?

Summary

This chapter detailed the literature relevant to this study. This chapter described the major components as I deemed it relevant to this study. The literature included mathematics education, distance learning, online learning, instructor beliefs, pedagogical practices, and online instruction. The following chapter will explain how I used Samuelowicz & Bain’s (2001) Learning-Centered Orientations to organize and explain the data.
CHAPTER 3: METHODOLOGY

This chapter describes the research methodology, which was qualitative case study and the research design, including the site, participants, methods of data collection, data analysis, and the trustworthiness of this study.

Research Methodology

This study was developed to respond to the instructor’s beliefs and decisions that impact the pedagogical practices in an online mathematics education course. Those decisions were influenced by the association of belief dimensions and learning-centered orientations. The research question that guided this study was:

What model can be produced when examining an online mathematics education course using a framework focused on instructor belief dimensions and learning-centered orientations?

To detail the components of that model I spoke to the following secondary questions:

1. What are the learning-centered orientations of the instructor’s online teaching practices?
2. How do the instructor’s belief dimensions influence his (her) on-line teaching practices?

It was my intention to gain an in-depth understanding of the reasoning associated with the instructor’s actions in online course; because I was looking for in-depth understanding it was necessary for this study to use qualitative research methodology (Glaser & Straus, 2004).

Because I was the researcher (by that I mean the only person collecting data and performing analysis) it gave an opportunity for me to be responsive, adapt to circumstances that arose, processed data immediately therefore directing the next steps in data collection, and the I also clarified and summarized data as the study progressed, which Guba and Lincoln (1981) also state supports qualitative research. These reasons and my research questions confirmed that this study would be best supported by qualitative research methodology. A study of beliefs and pedagogy does not support a simple yes or no answer, and because I did not know what I would find it is necessary for me to listen, explore, and discover meaning of situations which further validated the need to use qualitative research methodology (Akdemir, 2006).

Qualitative research requires the researcher to “enter into the lives of the persons being
studied as fully and naturally as possible” (Stainback & Stainback, 1988, p.1). While studying this online course, I had to fully enter the course without any acknowledgement or disturbance to the students or the instructor. Qualitative researchers:

a) Work best with a limited number of cases or situations.
b) Explore attitudes, opinions, and beliefs of a number of parties involved.
c) Study concepts or ideas that are clarified by theoretical or conceptual framework.
d) Establish and focus on the design and techniques of the study.
e) Collect data by observation, interviews, and through in-depth case studies.
f) Find relevant documents to examine.
g) Sort the data reading transcripts and field notes to make sense of information collected.
h) Finally, “tell the story” of the research experience by writing a report for dissemination (Brantlinger et al, 2006; Greenblatt, Dickinson, & Simpson, 2004).

Case Study

I used a single case study defined as an exploration of a bounded system, or a case over time that is detailed and exhibits an in-depth data collection involving multiple sources of information rich in context (Motteram, 2006). The case study approach was the best form to report on evaluations because it incorporates the collection and analysis of data from one case in an effort to reveal as much as I could about that particular case (Guba & Lincoln, 1981). The case study for this study was the instructor of an online mathematics education course. I examined the instructor’s beliefs and pedagogical practices by analyzing two courses taught by this instructor. Having two sources gave me the opportunity to identify different pedagogical practices (if there were any) and gave more of an opportunity to determine if the instructor’s beliefs varied depending on the difference of the learners or swayed due to the differences in the course (Merriam, 1998).

One may assume that pedagogical practices and beliefs are static, it is not expected that instructor’s pedagogical style would change from course to course, at least that is the idea behind the traditional face-to-face course (Huang, 2002). This may not be the same assumption for online courses, as researchers like Rovia (2002) state that instructors in an online environment must adapt to the environment, be creative, and are charged with keeping all students involved, which may cause the instructor to change his or her pedagogical style from course to course, or class to class. Multiple data sources (online courses) taught by the same instructor (case study)
kept these things in perspective, therefore allowing this study to concentrate on the style of one instructor in different courses. Having a secondary course taught by the same instructor was available to add validity to the results of the study. One course was taught over the Summer 2007 semester and the other course was taught in the Fall 2005. The Fall 2005 course was accessible through course archives and course documents were used; the Summer 2007 course was reviewed by documental data, interviews, and observation which were necessary to understand, identify, and evaluate beliefs and pedagogical practices in that course. The information from the Fall 2005 course was used as comparison or contradiction to actions within the Summer 2007 course. Descriptions of the courses are as follows:

**Research Site**

**a) Courses**

This study used two courses titled Seminar in Teaching Geometry. These courses were taught by the same instructor; one in Summer 2007 and an archived course taught in Fall 2005. I used the course taught in the Summer 2007 as the main source of the data. The instructor and the students that were observed (the term observed in this study means I reviewed course dialogue between student to student and student to instructor) and participated in email exchange were actively involved in this course during the timeline of the study. There were a total of twenty-six students enrolled in this course. The course taught in the Fall 2005 was used as validation (or contradiction) at relevant periods during the study. There were thirty-eight students enrolled in this course.

The courses are tailored to practicing middle and high school mathematics teachers seeking to earn a Masters degree. The mathematics education program is not designed to emphasize content development; instead the program’s focus is on mathematics teaching methods, research, pedagogy, and philosophy. The university offers a Master of Science in Mathematics Education in a face-to-face medium and through the distance learning program. In the distance learning program all courses are offered online. The degree requires all students to be practicing middle school and high school students. This master’s program requires students to complete a minimum of thirty-two semester hours. This course is one of twelve course offered to meet that requirement. This course will earn the students two credit hours (http://www.coe.fsu.edu/DistanceLearning/mathed.html, 11/7/07). The syllabus (Appendix E) describes the course by stating,
This course will examine current literature on learning and teaching geometry. Through class activities and assignments curriculum aligned with state and national standards will be explored. Activities will provide the opportunity to develop knowledge of appropriate manipulatives to use in the development of geometric concepts. Focus will be primarily on topics appropriate for 6-12 mathematics classes, with some extensions into post-secondary applications. (Course Syllabus, 2007, p. 1)

b) University

The courses were taught at a university that is an internationally recognized teaching and research institution committed to preparing the graduates for society, the main campus is located in North Florida. This university offers three online undergraduate Bachelor of Science degree programs: Computer Science, Interdisciplinary Social Science, and Nursing. The university also offers graduate degree and certification programs that allow adults to earn degrees in an online environment:

- Business Administration, Masters
- Management Information Systems, Masters
- Risk Management/Insurance, Masters
- Communication Disorders, MS
- Criminology & Criminal Justice, MS
- Educational Leadership/Administration, MS
- Information Studies, MS
- Instructional Systems (emphasis in Performance Improvement & Human Resource Development, MS)
- Instructional Systems (emphasis in Open & Distance Learning)
- Mathematics Education, MS
- Nursing, MS
- Physical Education, MS
- Science Education, MS
- Social Work, MS (http://learningforlife.fsu.edu/online/index.cfm, 12/7/2007)

This university’s commit to online success is further evidenced by its dedication to the students and the faculty. This university provides a web-site to support the complete online experience. The website includes a local and toll free phone number and the following links that offer direction to relevant information:

Prospective Online Students
Graduate
Undergraduate
c) **Timeline**

The timeline for this study was the summer semester, beginning May 2007 through August 2007. Over that period I examined the beliefs and their implications on pedagogical practices of this online mathematics education course, from the instructor’s perspective. I accomplished this task by collecting data over a full semester.

During the semester I:

a) Exchanged email with the instructor and two students (see Appendix C and D).

b) Downloaded course artifacts and documents from the Blackboard learning system.

c) Reviewed the activity and participation of the course dialogue.

**Participants**

a) **Unobtrusive Participant Observer**

My role was two-fold: I was an unobtrusive participant observer while observing the online course, but my interactions with the instructor could have been classified as participant observer. Alder and Alder (1994) describe a participant observer as a researcher who works closely with the subject (the instructor) to develop identifiable characteristics without participating in course assignments and activities. I developed silent relationships (reviewing email strings of students) with the members of the class, which gave me an opportunity to learn information that would otherwise be unavailable.

Though I was an unobtrusive participant in regards to observing the course and collecting

3 Blackboard E-Learning tool is a course management system used for distribution of course materials, communication, and interaction in an online environment. It is one of the three more well-known platforms for online learning (Zemsky & Massey, 2004; Lytras & Pouloudi, 2002)
documental data, I was more like a participant observer to the instructor because I:

- Conversed with the instructor through email.
- Made observations of the instructor’s interactions, communication skills, student responses, and course documents.
- Noticed comments, actions, and responses from the instructor that also fuel other questions.
- Recorded observations.
- Recorded responses to questions.

b) Instructor

Purposeful sampling was used in selecting this instructor. He was chosen due to his accessibility. Purposeful sampling is described as intentionally choosing subjects that meet the criteria necessary and relevant to this study (Greenblatt, Dickinson, & Simpson (2004). Using an available and accessible subject (the instructor) gives more opportunity (if necessary) to gather more information for a secondary analysis.

This instructor was awarded a scholarship by the Turkish Ministry of National Education towards a masters and doctoral degree in mathematics education. He then became a student and eventually graduated from the institution were this study is focused. The instructor’s dissertation is titled *The Influence of Curiosity and Spatial Ability on Preservice Middle and Secondary Mathematics Teachers’ Understanding of Geometry*. His dissertation investigated the geometric thinking while considering curiosity types, spatial ability levels, and motivation.

The instructor earned his masters and doctoral degrees from the same institution and program where I am receiving my doctoral degree. The instructor was born in Ankara, Turkey, and once he completed his graduate degrees he returned to Turkey (a requirement of his scholarship). He is currently an assistant professor in the mathematics department at Yildiz Technical College. For the past two and half years he has taught Calculus, Technical English, Textbook Analysis in Mathematics Education, and Teaching Methods in Mathematics Education at Yildiz Technical College. He has also taught online courses as a solo teaching opportunity (outside of Yildiz Technical College), those courses include Problem Solving and Seminar in Teaching Geometry, and both were taught two times each. While in graduate school this instructor worked as a teaching assistant in the Department of
Mathematics and the program of Mathematics Education each in a different college. While a teaching assistant in Mathematics Education he mainly assisted with various online courses from 2001-2005.

While participating in this study, this instructor taught the online course used in this study, taught face-to-face courses at Yildiz Technical College, and was actively writing grants and articles for journals. He has taught the Seminar in Teaching Geometry course twice, but had several years of teaching experience as either the teaching assistant or an instructor (Email exchange, 11/9/07). An experienced instructor is valuable to the assessment of beliefs because experienced instructor’s beliefs are not easily swayed by circumstances in the course, the textbooks used, or any other external or internal situation that may arise (Ernest, 1988). An experienced instructor also understands what works best in an online environment, and the experienced instructor would not typically force fit a particular teaching pattern because he or she was instructed to do so, but a novice teacher might.

c) Students

Though the main focus of this study is the instructor, his beliefs, and his pedagogical practices, it was necessary for me to evaluate student responses and correspondence within the course. I reviewed the student responses and downloaded documental communications to further analyze the instructor based on the work of Samuelowicz and Bain (2001). During certain points of the course, I found it necessary to interview students. I sent the entire class a set of questions (Appendix D); these questions gave me an opportunity to identify potential willing willing participants. Only four students responded to the initial questions. I then asked those four students another set of questions, only two responded. These two students were then considered the participants for this study. The students were selected based on their continued participation in responding to the questions; these students volunteered and I accepted their assistance. For the purpose of confidentiality I call the students, Student A and Student B and I refer to both of them as males.

Student A is from Hillsborough County, Florida. He has been teaching for fourteen years and the past eleven years he has been teaching high school. It has been roughly ten years since he taught geometry, and as a student he learned geometry by memorization. He described his skill set as rusty, but felt he was able to learn quickly despite his education. This student has been successful in the program (with success measured by a passing grade)
(Course artifact, 5/9/2007). This student is unsure of a graduation date, but plans to take more classes over the Summer 2008 semester. When asked the expected graduation date, Student A responded was unsure, but jokingly responded that he may need to attach his computer to his walker (Email exchange, 12/14/2007).

Student B is from Santa Rosa County, Florida. He has been teaching middle school mathematics for three years; he is currently teaching sixth grade. He stated that geometry had been sprinkled in his teaching experiences, but his last experience with a geometry course was when he was in the tenth grade (an honors geometry course). He further stated that he enjoys geometry; it allows him to think visually, sequentially, and explore the world around him. This student should complete this program in the Spring 2008. (Course artifact, 5/9/2007)

**Data Collection**

It was important to use a wide variety of data collection methods when studying a phenomena; using various data collection methods allows the phenomena to be examined from multiple angles which support data triangulation (data from many sources in order to reach a conclusion). Data collection in qualitative research generally includes two processes: interviews and observation, and depending on what the study is referencing, qualitative research could also include studying documentation (Farbar, 2006). I collected data by interviews, observation, and documental downloads from the course; by using these three sources, the collected data was triangulated so that data can be confirmed and substantiated.

![Data Triangulation Diagram](image)

*Figure 3.1 Data Triangulation*

Data Collection:

a) Email Exchange

The instructor preferred to communicate through email as opposed to chats (Email
exchange, 03/29/07). Because the instructor is in Turkey phone conversations were not practical. The term email exchange is used to define the communication between me and the instructor and me and the students over the email. In a verbal conversation this communication would be considered an interview.

These email exchanges were convenient to this study because this study is situated in an online environment. The email exchanges allowed me to communicate with the participants in an environment natural to the study. I observed that email exchanges have limitations not apparent in a traditional interview. The noted limitations in communicating through email exchanges are as follows:

- **Possible delays in communication.** There were three instances were I had to remind the instructor to respond to my questions. He apologized for the delays, but explained that he was busy and would get to them very soon. It was not apparent that he did not minimize the importance of his responses; there were just times that he could not be as responsive (Email exchange, 5/29/2007; 6/5/2007; 6/29/2007).

- **Facial expression and body language are unnoticed.** These characteristics are not noted in an online environment either. Therefore I considered this a positive attribute. Without consideration of facial expression and body language I only analyzed the dialogue in the course and the responses to email exchange. My review did not consider facial expressions or body language, therefore reducing possible baises.

- **Responses are short.** There is potential for the instructor and the students to be less responsive (in comparing the possible responses in a traditional interview). The responses were sometimes brief and sometimes lengthy. The instructor described himself as not very talkative (Email exchange, 8/17/2007), so I am not sure that his responses would have been very different in a traditional interview. He did address questions and express himself well. His responses were adequate.

Being that this study was focused on the online environment, the preferred and necessary method of communication was over email. The interview sample was gathered at random periods in the course. Below is the timeline of the email exchanges. Table 3.1 describes the participant, the dates of their responses, and the general topic of that discussion.
Table 3.1

**Timeline of Email Exchanges**

<table>
<thead>
<tr>
<th>Participant</th>
<th>Response Date</th>
<th>Topic of Discussion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructor</td>
<td>May 19, 2007</td>
<td>Teaching styles and beliefs</td>
</tr>
<tr>
<td>Instructor</td>
<td>June 6, 2007</td>
<td>Pedagogical practices and his philosophy</td>
</tr>
<tr>
<td>Instructor</td>
<td>June 22, 2007</td>
<td>Content knowledge (Geometry)</td>
</tr>
<tr>
<td>Instructor</td>
<td>June 27, 2007</td>
<td>Course activities and his constraints</td>
</tr>
<tr>
<td>Instructor</td>
<td>June 27, 2007</td>
<td>Response to questions about the nine belief dimensions</td>
</tr>
<tr>
<td>Instructor</td>
<td>August 17, 2007</td>
<td>Passive voice, knowledge of geometry, and beliefs</td>
</tr>
<tr>
<td>Student A</td>
<td>July 24, 2007</td>
<td>General questions about this online course and the instructor</td>
</tr>
<tr>
<td>Student A</td>
<td>July 30, 2007</td>
<td>Response to questions about the nine belief dimension</td>
</tr>
<tr>
<td>Student A</td>
<td>December 14, 2007</td>
<td>Response to questions about graduation</td>
</tr>
<tr>
<td>Student B</td>
<td>July 25, 2007</td>
<td>General questions about this online course and the instructor</td>
</tr>
<tr>
<td>Student B</td>
<td>August 11, 2007</td>
<td>Response to questions about the nine belief dimension</td>
</tr>
</tbody>
</table>

The interviews with the instructor were semi-structured (as referenced in traditional interviews), which were better suited for this study because the research question required data about the instructor’s personal beliefs, opinions, and knowledge. This level of insight is difficult to obtain through structured interviews, which limits a researcher’s ability to elaborate on topics of interest. Unstructured interviews are more like open-ended conversation without particular boundaries, which would not assure that I would gather the necessary data. Therefore, I asked questions to ensure that my purpose was not lost, but I did expect that other questions would evolve and I took the opportunity to ask those questions that may have been generated from the original questions; this describes semi-structured interviews which are flexible to capture insights that may otherwise be lost during structured interviews (Merriam, 1998).

b) Course Review

Observations include descriptions of the participants, descriptions of the physical settings, and accounts of particular events and activities (Bogdan & Biklen, 1998). Because this study involved an online environment, the course was not observed in the traditional definition. Instead I reviewed course dialogue, assignments, and email exchanges. During the semester I reviewed the course to confirm what the instructor identified as beliefs, identified techniques and pedagogical practices, and I identified the interactions within the course. This course review allowed me to collect less visible data, and document things that are relevant to the study; observations allowed invisible data to become visible (Akdemir, 2006). This
study considered invisible data to be the comparisons of the two courses, the instructor and student responses, and the comparisons of the students. The Blackboard E-Learning system includes several tabs: Discussion Boards: The instructor typically post topics that students respond to, the students can read other responses and respond as frequently and as freely as they deem necessary; Assignments: The Assignment tab is similar to the Discussion tab but the instructor post assignments. The students can submit their response while other students respond as deemed appropriate; Group Assignments; Group Assignments are more controlled. Once the groups are defined, the group members are allowed access to their group’s posting site; Announcements: the instructor post relevant announcements, and Course Documents: the instructor post course documents as deemed appropriate. Students can assess the documents throughout the course. I made observations by reading these correspondences.

c) Artifacts

Farbar (2006) refers to documental data as photographs, videos, diaries, manuals, memos, instructional materials, case records, course records, and memorabilia of all sorts than can be used as additional information to supplement observations and interviews. For this study, the documents that were used in support of this study were the course records and instructional materials.

Over the semester time period, I downloaded course documents and used these for analysis of this study. The Blackboard e-learning tool incorporates discussion boards, assignment posting, Frequently Asked Questions, group email, and posting capabilities. These documents allow the instructor an opportunity to appropriately assess the student’s achievement level in the course.

Data Analysis and Coding

The interviews, observations, and documental data were analyzed to determine the beliefs and the influences those beliefs have on the pedagogical practices of an online mathematics education instructor. I analyzed the data by using a theoretical framework titled Learning – Centered Orientations and Belief Dimensions presented by Samuelowicz & Bain (2001). This framework was presented in Chapter 2, Literature Review and it is necessary because it offered simplicity to a somewhat complex phenomenon (i.e. instructor beliefs and pedagogical practices). Frameworks add value to the analysis and give the audience a better understanding of
the study (Jacob, 1988). This framework evaluated the core concepts of the study: instructor beliefs and pedagogical practices.

Coding is organizing data into categories on the basis of themes, patterns, concepts, or similar features (Neuman, 1997). In order to do so, I sorted through the data using the previously defined frameworks to assist in identifying recurring themes, patterns, or concepts which were then be labeled and categorized to explain the findings. Coding structures should be simple and relevant to the study (Lincoln & Guba, 1985). Initially I added coding labels to the framework presented earlier. Each cell produces something similar to (x,y) coordinates. For example, Table 3.1 shows that the code of (A,1) would mean that that particular data fit into Desired Learning Outcome and Helping Students Develop Expertise. Coding the data was not simply tagging elements with the obvious codes; I had to rely on my course review and my experience as an online student, and the expertise I gained through research to appropriately code the data. My experience allowed me to relate to the responses of the student. My interpretation gave opportunity for further assessment and appropriate coding (as I thought relevant). This type of coding was used throughout the collected data because it is my intention to have minimal findings unassigned to a coding category (Guba & Lincoln, 1981). Once the initial labeling was completed, I re-ordered the belief dimension in like sections. These sections will be presented in Chapter 4 capturing the results of the data; these sections allowed the summaries to be much more simplified and easy to understand: Pedagogical practices and beliefs: The Instructor’s Expectation of the Online Course, Pedagogical practices and beliefs: Pedagogical Knowledge, and Pedagogical Practices and Beliefs: The nature of instructor-student interaction.

Table 3.2

<table>
<thead>
<tr>
<th>CODE GRID</th>
<th>Learning – Centered Orientations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td>A</td>
<td>Desired learning outcomes</td>
</tr>
<tr>
<td>B</td>
<td>Expected use of knowledge</td>
</tr>
<tr>
<td>C</td>
<td>Responsibility for organizing or transforming knowledge</td>
</tr>
<tr>
<td>D</td>
<td>Nature of knowledge</td>
</tr>
</tbody>
</table>

Code Grid for Learning – Centered Orientations and Belief Dimensions
Limitations of the Study

The findings of this study cannot be generalized to every online mathematics education instructor. In actuality, qualitative research is not done for the purpose of generalization; instead, qualitative research details the results of an exploration of a specific phenomena, which in this case are teacher beliefs and the influence those beliefs have on the pedagogical practice of an online mathematics education course. It is hoped and expected that the audience that reads this study can find similarities to their experience either as an instructor, student, or policy developer. If the audience is able to relate to this study, if the study is able to influence instructional practices, if this study leads to future studies or if it identifies better pedagogical practices informed by teacher beliefs and learning-centered orientations of an online mathematics education course – the study is successful (Guba & Lincoln, 1981; Brantlinger et al, 2005).

Trustworthiness of the Study

Research studies are intended to be believable and accurate, qualitative research has the same charge of being credible and trustworthy (Creswell, 1998). By credible, I mean that the study should offer validity to the fact that the findings of this study are consistent with reality. By trustworthiness, I mean that the study should be reliable which supports that if repeated, the same results should be discovered. To support that this study should be considered valid and reliable, I would take direction from the model presented by Merriam (1998). This researcher provided several factors that can contribute to successful validation of studies and research. My study incorporated the following four components presented by Merriam:

Table 3.2 - Continued

*Code Grid for Learning – Centered Orientations and Belief Dimensions*

<table>
<thead>
<tr>
<th>CODE GRID</th>
<th>Belief Dimensions</th>
<th>Learning – Centered Orientations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Helping Students</td>
<td>Preventing Misunderstandings</td>
</tr>
<tr>
<td></td>
<td>Develop Expertise</td>
<td>Used to prevent common mistakes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Used as basis for conceptual change</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Encouraging Knowledge Creation</td>
</tr>
<tr>
<td>E</td>
<td>Students’ Existing Conceptions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Not taken into account</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Used to prevent common mistakes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Used as basis for conceptual change</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Encouraging Knowledge Creation</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>Teacher-Student Interactions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Two-way to negotiate meaning</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Used as basis for conceptual change</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Encouraging Knowledge Creation</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>Control of Content</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Teacher</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Used to prevent common mistakes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Used as basis for conceptual change</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Encouraging Knowledge Creation</td>
<td></td>
</tr>
<tr>
<td>H</td>
<td>Professional Development</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Stressed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Used as basis for conceptual change</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Encouraging Knowledge Creation</td>
<td></td>
</tr>
<tr>
<td>I</td>
<td>Interest and Motivation</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Students’</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Used as basis for conceptual change</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Encouraging Knowledge Creation</td>
<td></td>
</tr>
</tbody>
</table>
1) Triangulation: This study incorporated interviews, observations, and documental data which represented multiple sources of data that will contribute to the findings of this study.

2) Member Checks: This study was focused on the implications of the instructor; therefore the interviews revealed what the instructor felt are his beliefs and his pedagogical practices and why those practices work best for him. While observing the course, I determined if what the instructor ‘says’ are his actions, were in fact his actions while facilitating the course. I also observed behaviors in the course and stated my observations to the instructor, asking if my observations were correct. This member checking creates a reality that Lincoln & Guba (1985) describe as internal validity which is a major strength of qualitative research.

3) Review of Course Dialogue: I observed the course and an archived course over a summer semester. The observation in this study consisted of reading course dialogue between students and students to instructor. I also reviewed responses to group assignments, comments in the assignment tab, and the discussion board.

4) My Biases: My views have been disclosed thought my study. It is important for the research to detail his or her views, opinions, and thoughts related to the study at hand. This forthcoming will give the readers a full picture of research in the results of the study, which will keep the study and the findings in perspective (Brantlinger et al, 2006).
CHAPTER 4: RESULTS

I will discuss the details and the analysis of the data collection in this chapter. Data were collected by interviewing the instructor and students, downloading course artifacts, and by conducting observations of the course. These data were collected over a semester long Seminar in Teaching Geometry, an online mathematics education course. To make the data useful and clear for understanding and discussion they were organized into common categories and coded. These categories were structured by using a framework presented by Samuelowicz and Bain (2001) titled Teaching-Centered and Learning-Centered Orientations to Teaching and Learning Defined in Terms of Their Constituent Belief Dimensions and Beliefs. For simplicity the framework was termed Learning-Centered Orientations and Belief Dimensions. In the previous chapter, I represented the relevant portion of the framework of Samuelowicz and Bain and also included the coding grid that was used to organize the data (Table 3.1). This framework guided and offered interpretation of the data. The main premise of this particular framework is that instructor belief orientations can be ordered to show contrast in knowledge construction and learning facilitation.

This framework produced thirty-six coding strategies; to present and discuss the findings as clearly as possible I grouped the nine belief dimensions into three general categories. This chapter is outlined using those general sections: 1) pedagogical practices and beliefs related to instructor’s expectation of the course, 2) pedagogical practices and beliefs about knowledge of the instructor, and 3) practices and beliefs in relation to teacher-student interaction. Table 4.1 shows how the nine belief dimensions are situated within these general categories.
Table 4.1  
\textit{Sections and Relative Belief Dimensions}

<table>
<thead>
<tr>
<th>Section</th>
<th>Belief Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) Pedagogical Practices and Beliefs: Instructor’s Expectation of the Course</td>
<td>Desired Learning Outcomes</td>
</tr>
<tr>
<td></td>
<td>Expected Use of the Knowledge</td>
</tr>
<tr>
<td></td>
<td>Professional Development</td>
</tr>
<tr>
<td>2) Pedagogical Practices and Beliefs: Knowledge</td>
<td>Responsibility for Organizing or Transforming Knowledge</td>
</tr>
<tr>
<td></td>
<td>Nature of Knowledge</td>
</tr>
<tr>
<td></td>
<td>Students’ Existing Conceptions</td>
</tr>
<tr>
<td></td>
<td>Control of Content</td>
</tr>
<tr>
<td>3) Pedagogical Practices and Beliefs: Teacher-Student Interaction</td>
<td>Teacher-Student Interactions</td>
</tr>
<tr>
<td></td>
<td>Interest and Motivation</td>
</tr>
</tbody>
</table>

Each section also includes a restatement of the segment of the framework that is relevant to that particular section. As each section concludes there will be a representation of the model that evolved as the data was filtered through Samuelowicz and Bain’s (2001) framework. The resulting models will be compiled and discussed in Chapter 5 to respond to the research questions. The primary research question is:

What model can be produced when examining an online mathematics education course using a framework focused on instructor belief dimensions and learning-centered orientations?

In answering this question, I will also answer two secondary questions:

What are the learning-centered orientations of the instructor’s online teaching practices?

How do the instructor’s belief dimensions influence his on-line teaching practices?

\textbf{Data Collection and Categories}

The data focus on one instructor, examining the relationship between this instructor’s decision making and class activities. I interviewed the instructor throughout the summer course. For the purpose of discretion and protection of identity, the instructor will be called The
Instructor. I also found it necessary to gain some insight into what the students’ thoughts and opinions of the instructor were, so I also interviewed two students. These students were used because of their willingness to participate. Their thoughts, opinions, and responses may not be representative of the entire population of students in this course. Those students will be referred to as Student A and Student B.

Pedagogical Practices and Beliefs: The Instructor’s Expectation

The purpose of this study was to evaluate the instructor’s practices and decision making in the online course, Seminar in Teaching Geometry. The evaluation process begins by first understanding and evaluating the instructor’s overall expectations of the course, which are summarized in this section. The results are coded based on my interpretation of the framework presented by Samuelowicz and Bain (2001). Recall that this particular framework explains that there are nine belief dimensions. This section will capture the results of the three belief dimensions: desired learning outcome, the expected use of knowledge, and professional development. Table 4.2 represents the specific segment of the framework under analysis; the “L” represents that Samuelowicz and Bain found these orientations to be learning-centered. After discussing the data relevant to this section, I will introduce a model of these same belief dimensions as relevant to this online course.

Table 4.2
First Segment of the Framework: Instructor’s Expectation

<table>
<thead>
<tr>
<th>Belief Dimensions</th>
<th>Helping Students Develop Expertise</th>
<th>Preventing Misunderstandings</th>
<th>Negotiating Understanding</th>
<th>Encouraging Knowledge Creation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desired learning outcomes</td>
<td>Change in ways of thinking</td>
<td>Change in ways of thinking</td>
<td>Change in ways of thinking</td>
<td>Change in ways of thinking</td>
</tr>
<tr>
<td>Expected use of knowledge</td>
<td>Interpretation of reality</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
<tr>
<td>Professional Development</td>
<td>Stressed</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

L: Learning Centered
**Desired Learning Outcomes**

At the beginning of the course I reviewed the course syllabus (Appendix E). The syllabus outlined the course detailing the instructor’s contact information, a brief description of the content, the required materials, the objective, the teaching strategies, assessment and participation. The course syllabus is one of the first opportunities for students to understand what the course can offer and for students to determine if there is potential for their learning outcomes to be achieved. To delve further into the instructor’s desired learning outcomes, I specifically asked the instructor about his desired outcomes for the students in this course. He replied,

> Well, to be able to give geometry instruction properly; to know important constructs in geometry (spatial ability, van Hiele levels); to know about the current research in geometry; to be able select questions to promote creativity. (Interview, 07/27/2007)

Along with interviews, I also observed the course and collected artifacts from the course. The instructor posted documents that were relevant to the course; one document titled *My Students’ Performance is Beyond the Scope of the Class: An Exploratory Model of Instructional Design* (Appendix F) specifically speaks to instructor’s expectation. Figure 4.1 is an excerpt from that document. This figure showed that the instructor expected student performance to vary widely, but expected knowledge to be more focused by the end of the semester.

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**Figure 4.1 Excerpt from My Students’ Performance is Beyond the Scope of the Class: An Exploratory Model of Instructional Design**

All the instructors have expectations for students. They want them to master the content of the course. It is unfortunate that not many students reach the level that teacher expected. Very few show performance above the teacher expectations which is beyond the scope of the class (A+ STUDENTS). This performance is shown most of the time on certain topics rarely whole topics in the course. Some students fail (F students).

At the end of the course student performance

When the semester is over students’ knowledge move toward to the center
Though this study was specifically focused on the instructor, when assessing the desired learning outcomes of the instructor for his students, it was necessary to understand what were the students’ desires. If the instructor’s learning outcomes did not mirror (or have considerable similarities to) the students’, the students would be frustrated because their expectations would not be met. To be sure the instructor’s desired learning outcomes were comparable to the students learning outcomes, I felt compelled to compare their expectations. Therefore, I asked the students what their desired learning outcomes were and their responses are noted in Table 4.3.

Table 4.3

<table>
<thead>
<tr>
<th>Respondent</th>
<th>Response to Desired Learning Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student A</td>
<td>I wanted to learn more and better ways to break down and present geometry to students. Of all subjects that I have taught, geometry is the only subject that has consistently been given little attention throughout my college education. It would have been nice to have been able to have this void filled or at least addressed. (Interview, 7/30/2007)</td>
</tr>
<tr>
<td>Student B</td>
<td>My desired outcome was to learn more about teaching geometry to middle school students. I achieved this goal, but I think that my learning would have been more beneficial had the class been more directed towards middle school teachers than math teachers in general. Many of the activities were for high school teachers and high school geometry students, and, as I do not plan to teach those grades, some of the class was lost on me. (Interview, 8/11/2007)</td>
</tr>
</tbody>
</table>

The instructor and the students gave specific desired learning outcomes. In evaluating the desired learning outcomes the framework explains that there should be a change in the way the learner thinks in all four learning-centered orientations: helping students develop expertise, preventing misunderstanding, negotiating understanding, and encouraging knowledge creation. Regardless of the learning orientation the over-arching goal of this course is the expectation of change in the ways the learners think about geometry. The actual desired learning outcome of the students or instructor was not under evaluation. The analysis is to determine if there is an expectation of change in the thought process. The framework simply explains that the instructor should expect a change in ways of thinking. Based on the responses, artifacts, and my observations it is sustained that this instructor and the students expected a change in ways of thinking.
Expected Use of Knowledge

Though it was not necessary to assess the actual responses when evaluating the desired learning outcomes, it is necessary to assess the actual responses when attempting to understand and access the instructor’s expectation of the students’ use of knowledge. The previous responses (Table 4.3) showed that there were similar expected outcomes in taking this course on the part of the student. The slight variation is related to individuality of each student. Student A wanted to “learn better ways to present geometry to students” and Student B went a step further and stated that he wants to “learn more about teaching geometry to middle school.” When I asked the instructor how he expected the students to use the knowledge from the course, he responded:

My expectation is that they need to use this knowledge to expand their knowledge on how to teach geometry in their classes. (Interview, 07/27/2007)

The instructor and the students wanted and expected to take the knowledge from this course and use it when they teach geometry; the application of that knowledge to their teaching experiences would be “interpretative of their reality” (Samelowicz and Bain, 2001). Interpretative of their reality means each learning experience generates varying meanings for each student and then those students will take that knowledge and apply it to their individual realities.

The framework evidenced that when discussing the expected use of knowledge against the four learning-centered orientations the expected use of knowledge from the course is an interpretation of reality. The instructor expects the knowledge will be used as an interpretation of reality in each of the learning orientations: helping students develop expertise, preventing misunderstanding, negotiating understanding, and encouraging knowledge creation. This is evidenced in this course because the course is designed for knowledge to be constructed by the learner as referenced in a comment by both students and the instructor. The link to constructivism and the terminology “interpretation of reality” is evidenced in the work of Oliver and McLoughlin (1999), where they state that constructivists support that learners construct their own knowledge by being active participants in the learning process. They expressed that the main characteristics of constructivism are the emphasis of personal understanding and meaning making, students being active and interpretative, and knowledge construction and integration.

Student B stated, “We certainly constructed our own knowledge. I plan to use this knowledge by taking the theoretical basis and applying it to actual lessons” (Interview, 8/11/07). This response supports that as this student becomes the instructor, the knowledge in this online
course will become prior knowledge that will be used in his actual lessons when he is the instructor. It does not matter what learning-centered orientation is analyzed, the entire course was designed for knowledge construction, thereby leaving opportunity for student interpretation based on their realities. Student A did not seem so accepting of the constructivist principles and exhibited signs of frustration at the instructor allowing the students to construct knowledge. He stated, “Proper construction needs a proper foundation, one cannot build in thin air” (Interview, 7/30/07). Based on this response, I concluded that this student is not a proponent of constructivism. Even with the opposition to constructivism this student still expected to use this knowledge in his experience as an instructor, supporting that knowledge will be used as an interpretation of his reality. In each learning-centered orientation the knowledge will be used as an interpretation of reality.

Professional Development

Professional development is one of the nine belief dimensions presented by Samuelowicz and Bain (2001). The students in this online course are seeking their master’s degrees in mathematics education. These students are practicing teachers; therefore their professional development is related to their teaching experience. The framework states that the professional development will be stressful for the student. I noticed frustration from both of the students but none at all from the instructor. I asked each student to give me an example of what lesson/communication (from this course) they would take to their profession and why each felt that way. Student A responded, “I will remember that my students need challenges, not frustration” (Interview, 07/30/2007). This response implies that this student was frustrated which in turn denoted stress. Student A did exhibit signs of stress during the course, which was the expectation noted in the framework. I also noticed frustration in Student B’s response to the question, Do you really feel like you are learning anything? Student B responded,

I do feel like I am learning things, but I also feel limited in how much I am learning. In this program, the focus is on the theoretical, which is great, but rarely do our professors show us how to tie the theoretical to our practical, everyday teaching. That experience, now, would be beneficial, but, again, that is lacking in this online environment. (Interview, 07/25/2007)

It is not my intention to focus on the teacher interaction (or the lack thereof), but this communication was another opportunity to present the stress evidenced in the course. This statement is not ignored and it along with other data will be discussed later during the section on interactions.
The frustration denoted thus far is more evident when considering two of the learning orientations: helping students develop expertise and encouraging knowledge creation. When considering the other two learning-centered orientations (preventing misunderstandings and negotiating understanding) frustration was not the main outcome of professional development. Though the students exhibited signs of frustration with the instructor’s ability to help students develop expertise and instructor’s encouragement of knowledge creation, they both felt it was their responsibility to prevent misunderstanding and to negotiate understanding. Student A and Student B believe that they are responsible for their understanding. Student A stated that, “I learn no matter what” (Interview, 07/24/07). Student B stated that, “ultimately it is the students’ responsibility to create knowledge, that’s what learning is” (Interview, 08/11/07).

My observation of the course further supports that the learner had to be motivated to prevent misunderstanding and negotiate understanding in regards to the students’ professional development. The course design and the instructor’s intentions were to allow students to motivate themselves or each other. To create a better learning opportunity the instructor found it necessary to add more activities to the course to create a better learning opportunity for the students, those additions also served as a better assessment tool for the instructor (Interview, 07/27/07). My observations of the course, the interviews of the students and the instructor all support the theory that professional development is motivated by the learner as it relates to preventing understanding and negotiating understanding.

**Model of the Instructor’s Expectation Component: Modified Version**

Recall that the main question of this study involves disclosing the model created when the data from an online mathematics education course is analyzed using a framework focused on belief dimensions and learning-centered orientations. To address this question I will present the model that resulted once the data were analyzed. Earlier in this chapter I presented the segment of the framework related specifically to this section (Table 4.1). Based on observations, interviews, and the course artifacts, it is appropriate to state that in this online mathematics education course the segment of the framework proved accurate and was a useful instrument in evaluating the expectations of this online course.

The instructor expected the students to “use this knowledge to expand their knowledge on how to teach geometry in their classes” (Interview, 07/27/2007). The interviews and my observations supported that the knowledge from the course would be used as an interpretation of
reality for the students when they taught their own courses. The framework also expected some level of stress, the instructor did not show and communicate any signs of stress but the students expressed their frustration. Based on the results of the data collection from the students, there was frustration in the Professional Development aspect of the course. There was also an expectation that the students would depend on one another or that the students would create their own opportunities for learning.

Based on these observations, a model was produced. This model takes this online course and data of the three belief dimensions (desired learning outcomes, expected use of knowledge, and professional development) and presents the commonalities in Table 4.4.

Table 4.4

Instructor’s Expectation for this Online Mathematics Education Course

<table>
<thead>
<tr>
<th>Belief Dimensions</th>
<th>Learning – Centered Orientations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Helping Students Develop Expertise</td>
</tr>
<tr>
<td>Desired learning outcomes</td>
<td>Change in ways of thinking (Learner)</td>
</tr>
<tr>
<td>Expected use of knowledge</td>
<td>Interpretation of reality for Learners</td>
</tr>
<tr>
<td>Professional Development</td>
<td>Frustrated Learners</td>
</tr>
</tbody>
</table>

The notable modifications are noted by bold print. I use the term notable because I also made modifications for simplicity. Recall that Sameulowicz and Bain (2001) presented that when the learner was the influential party, it was represented by an ‘L’. I removed those initials and embedded those relationships into the actual resulting expectation. This change is not significant and therefore it is not bold. Table 4.2 stated change in ways of thinking, then noted with an “L” was underneath; I removed the “L” and modified the expectation to read, change in ways of thinking (Learner). I did not bold these occurrences because those changes were done for simplicity; the changes did not alter or impact the framework.

The significant changes are in the belief dimension of Professional Development and they appear in bold. The data from this study did support that frustration (as opposed to stress) was the main expectation in two of the four learning-centered orientations (Helping Students Develop Expertise and Encouraging Knowledge Creation); stress was not the main result in the other two orientations (Preventing Misunderstanding and Negotiating Understanding). The Professional Development in these two orientations was dependant and motivated by the learners.
and are represented in bold in Table 4.4.

**Pedagogical Practices and Beliefs: Knowledge**

In an effort to respond to the research question it became necessary to understand how the course progressed and what activities led to those objectives being achieved. Recall that the primary research question is:

**What model will be produced when examining an online mathematics education course using a framework focused on instructor belief dimensions and learning-centered orientations?**

In answering this question, I will also address two secondary questions:

- What are the learning-centered orientations of the instructor’s online teaching practices?
- How do the instructor’s belief dimensions influence his on-line teaching practices?

To address these questions I organized the data into three categories; this section will detail the second category. The detail of the data and the associated analysis relevant to knowledge construction will be discussed. This section begins by presenting the portion of the framework relevant to knowledge and knowledge construction. This section is further divided into details of each of the relevant belief dimensions: **Responsibility for Organizing or Transforming Knowledge**, **Nature of Knowledge**, **Student’s Existing Conceptions**, and **Control of Content**. Each belief dimension also includes the data analysis relevant to the four learning-centered orientations. Following the data analysis of the relevant belief dimensions and the learning orientations, I will present a model dependant on data from this online course.

The portion of the framework that speaks to knowledge is represented in Table 4.5. It shows that the relevant belief dimensions are **Responsibility for Organizing or Transforming Knowledge**, **Nature of Knowledge**, **Student’s Existing Conceptions**, and **Control of Content**. Samuelowicz and Bain (2001) used the “L/t” in the table to represent learning-centered with aspects of teaching emphasis; the “L” to represent learning-centered, and the “T” to represent teaching-centered.
The syllabus included a table of weekly assignments, the expected assessments, and suggested readings (Appendix E), providing some initial detail as to how the instructor intended for the course to proceed and how learning was to take place. Before looking at the aspects of the pedagogical dimensions within the course, I asked the instructor to describe the basis of his instructional decisions. He responded:

Let me answer this question based on my instructional decisions from beginning to end for a course so that you will get sense of my teaching styles and also my personal reasoning behind those instructional decisions. How do I make instructional decisions and why?

Some ideas and concepts during my graduate education really helped me to shape my teaching style:
1- Motivation as prerequisite for Learning (ARCS model Dr. Keller)
2- Curiosity driven instruction: Resulted in Exploratory behavior
3- Creativity as a product of curiosity
4- Scaffolding and Zone of Proximal Development: Assessing students’ knowledge, learning style, thinking mode and give individual and “stable feedback” to promote learning
5- Creating problem solvers (Interview, 05/19/2007)

It is interesting to point out that I asked the instructor to describe his instructional decisions; he described his instructional decisions as a product of his teaching style. The ARCS (Attention, Relevance, Confidence, and Satisfaction) model is a model that represents motivation, performance and instructional influence as a body of relationships (Keller, 1987).
later asked the instructor to describe his pedagogical practices; he made reference to his educational experience as a doctoral student where he learned about Vygotsky’s Zone of Proximal Development (Vygotsky, 1978). He responded,

I was working on Lev Vygotsky and his ideas; mainly my focus was on “Scaffolding” and “Zone of Proximal Development” at that time. My philosophy developed on this idea. If you are not in the zone of potential learning of students, there will be no gain.

Principle one: Assess students in many dimensions - thinking mode, previous experience, and learning style (Visual –nonVisual). (Interview, 06/06/2007)

In comparing each of the numbered responses (from above) there are similarities at the core of his teaching style: motivation, curiosity, and promotion of learning. I will not discuss these characteristics here because they are closely related to teacher-student interactions, a section later in this chapter.

**Responsibility for Organizing or Transforming Knowledge**

Before discussing the data relevant to this belief dimension, I found it necessary to discuss the title of the belief dimension. Samuelowicz and Bain (2001) termed this belief dimension *Responsibility for Organizing or Transforming Knowledge*, but from what was observed this online course did not lend itself to knowledge transformation. The terminology *transforming knowledge* (which means what is learned in school is somehow carried over to different circumstances and situations) is used in behavioral psychology (Casas, 2003). Samuelowicz and Bain consider knowledge transformation as a knowledge conveying strategy, however knowledge transformation is not the strategy utilized in this online course. The instructor did mention the term behaviorist in his response when I asked him to describe his teaching style and he responded, “I am not going to label my style as behaviorist or constructivist” (Interview, 05/19/07). Constructivists believe that learners construct their own knowledge by actively participating in the learning process (Chicione, 2004). Though the instructor did not label his teaching style, his actions, his responses to interview questions, my observation of the course and interviews of the students confirm that this course supported the principles of constructivism. The course and the instructor’s intentions were to allow students to construct knowledge. *Responsibility for Organizing or Constructing Knowledge* would be a dimension title more appropriate for this online course.

The framework supports the notion that when it comes to helping students develop
expertise, the student and the instructor has a responsibility for organizing or transforming knowledge (which I have disclosed is not an appropriate naming convention for this online course). Samuelowicz and Bain (2001) believe that the students are in control their conceptions, therefore the three remaining orientations (preventing misunderstanding, negotiating understanding, and encouraging knowledge creation) state that the student is responsible for organizing and transforming knowledge.

The instructor found sharing of responsibility similar to Samuelowicz and Bain (2001); he stated, “The learner needs to organize the knowledge. For the course the teacher needs to organize the potential knowledge” (Interview, 07/27/2007). When discussing this component with the students, their perspectives were very similar to that of the instructor. Student A stated, “those who are experts should be responsible for enough guidance to assure learners of progress” (Interview, 07/30/2007) and Student B said, “I think in a class setting, the expert/teacher is responsible for helping the student to organize and transform knowledge. Ultimately, it is the students responsibility but the expert’s job is to facilitate this process by serving as a model or mentor” (Interview, 08/11/2007).

Besides the course syllabus (Appendix E) there was also a document titled What Can I Expect from an Online Course (Appendix G) that also explained the role of the instructor, the students and the expectations of the online course. Figure 4.2 is an excerpt from that document. It, along with the comments from the instructor and the students, lends relative information about responsibility of knowledge in this online course.

What to expect from your professor and course mentors.

Online courses are "Student Centered" rather than "Professor Centered," so you will not sit and listen to long verbal lectures, you will not have routine homework (because all of your work is homework), and you may not be required to log into your course at any specific day and/or time unless required to do so by the professor. Your professor plays a different role from Face-to-Face. He/She will serve as a "facilitator" and will assist you in learning the material required; explain details clearly in writing; provide you with information links, requirements, web and online materials, references, etc… He/She will answer all email questions usually within 24 hours; correct all required work, papers, projects and quizzes as quickly as possible (usually in one weeks time of the assignment due dates); and post your grade in your grade book periodically.

Figure 4.2 Excerpt from What Can I Expect from an Online Course.(Course artifact, 05/08/2007)
The data (the interviews, the syllabus, the excerpt above, and my observations) revealed that the instructor has a responsibility of helping students develop expertise and the students have responsibility for preventing misunderstanding, negotiate understanding, and encourage knowledge creation.

**Nature of Knowledge**

The framework explains that the *Nature of Knowledge* is personalized to the learner in each of the learning-centered orientations. “Personalized” means that the students use the knowledge to benefit their independent teaching experiences, the knowledge then becomes personalized. In this course the potential was presented, but the instructor expected the learners to construct their own knowledge. Not only was that the intention of the instructor, but the two students who were interviewed recognized that they were expected to construct their knowledge as noted by responses in Table 4.6.

Table 4.6

**Responses Related to Nature of Knowledge**

<table>
<thead>
<tr>
<th>Question: Do you feel that you taught them or did the students construct their own knowledge?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Respondent</strong></td>
</tr>
<tr>
<td>Instructor</td>
</tr>
<tr>
<td>Student A</td>
</tr>
<tr>
<td>Student B</td>
</tr>
</tbody>
</table>

The following is an excerpt from the course artifacts. This excerpt is dialogue with the instructor and a random student (by random I mean a student other than Student A and B). It showed how the instructor guided the lessons. He does not give an answer, but simply offered his perspective.
The excerpt in Figure 4.3 is from the van Hiele Level assignment. The instructor considered the van Hiele assignment important because it represented important constructs in geometry (Interview, 07/27/2007). Yet the comment noted in Figure 4.3 is the only communication the instructor had with any of the students on this topic. There were fifty-seven responses from June 20 – July 29, and the instructor made the comment noted above on June 20th. This is not an evaluation of the instructor’s participation, but it does show that the instructor held students responsible for constructing knowledge. Based on the data, I would change this particular component from personalized to knowledge construction in each of the learning-centered orientations.

**Students’ Existing Conceptions**

Lefoe (1998) stated that constructivism supports that learners learn by observation, processing, and interpretation, and then personalizing the information into personal knowledge. Prior knowledge is an integral component in constructivism because learners typically interpret information according to their personal reality. Harrington (1999) states that prior knowledge is also necessary in online environments; pacing allows students to use their prior knowledge. Samuelowicz and Bain (2001) presented that there are varying expectations depending on the learning-centered orientation of this belief dimension. They stated that the resulting characterization of students’ existing conceptions would not be taken into account, used to
prevent common mistakes, and used as a basis for conceptual change. To assist in evaluation of this particular belief dimension, I asked, *Do you think the instructor used exercises to build on your prior knowledge or is your success in this class isolated from prior knowledge?*

The instructor stated that,

> All of the exercises are related to students’ prior knowledge. But some of them are more related; some of them less related. Take for example group problems, questions are asked differently for the purpose is finding solutions more than one way. Students need to realize that we are all different and why not use this difference in the class as an advantage.” (Interview, 07/27/2007).

The students agreed that prior knowledge was necessary; the noted differences include Student A expressed a slight frustration because of the lack of feedback in the online course and Student B specifically felt that geometric constructions did not rely on prior knowledge. He stated that geometric constructions were foreign to him, but he was still able to complete the assignment with no prior knowledge. Figure 4.4 is an extract from the course artifacts of the geometric construction problem.

```
Geometric Constructions by Ruler & compass

1-Construct a square:
   a) Given one side
   b) Given diagonal
   c) Construct a square, having given the difference between the diagonal and one side
   d) The sum of the diagonal and one side

2-Triangle
   a) a triangle, given the base, altitude, and one of the other sides.
   b) a triangle, given the base, altitude, and an angle at the base.
   c) a right triangle, given a leg and the altitude on the hypotenuse.
   d) a right triangle, given the altitude on the hypotenuse and one acute angle.
   e) an isosceles triangle, given the base and the altitude on one of the equal sides.
   f) an isosceles triangle, given the altitude on the base and a base angle.
   g) a right triangle, given the sum of the legs and an acute angle.
   h) a triangle, given the three medians.
   i) a triangle, given two angles and the perimeter.

3-Rectangle
   a) Construct a rectangle given a side and a diagonal.
   b) Construct a rectangle given the perimeter and one diagonal *(A real challenge)*

4- Construct a parallelogram, given
   a) Two adjacent sides and the included angle
   b) The diagonals and the angle between them
   c) One side, one angle, and one diagonal
   d) One angle, one side, and the altitude to that side.

You need to do 5 constructions from the list above. You can do by hand and scan the documents. Or you can do it by using geometry software (GSP or cabri). Submit it to the instructor via DDB.

P.S. Instead of 5 constructions you can only do "A real challenge" construction.
```

*Figure 4.4* The geometric construction problem (Course artifact, 05/08/2007).
Though Student B felt the exercise was not dependent on prior knowledge, the question and student participation support that access to prior knowledge made the problems less difficult than they could have been. Student B did not have existing conceptions of geometric constructions but he did have prior knowledge of geometry as implied by his experience as a geometry teacher (Interview, 08/11/07). Figure 4.4 is a problem associated with geometric constructions and although Student B expressed concern, there was only one dialogue about this problem. A student asked, “For the 5 constructions, do you want us to do a step by step demonstration? It is worth so much, it seems there is more to it. Am I missing something?” The instructor responded, “Yes step-by-step demonstration”. The student responded “10-4”. (Course artifact, 06/01/2007) Based on the lack of questions from all students (including Student B) it was concluded that students had some prior knowledge of geometric constructions or existing conceptions of the subject of geometry, making the problem manageable for students to arrive at a solution.

When considering the learning-centered orientations: helping students develop expertise, preventing misunderstandings, negotiating understanding, and encouraging knowledge creation, there was one characterization that was not supported by the data. Samuelowicz and Bain (2001) stated that the students’ existing conceptions were not taken into account when helping students develop expertise. This is not an accurate assessment in this online course. The instructor gave assignments that required the students to use their prior knowledge. There were no instances in my observation where prior knowledge was not taken into account. Bonk & Reynolds (1997) also stated that online learning environments must create challenging activities that allow the learners to link new knowledge and prior knowledge.

Control of Content

The framework indicates that the instructor is in control of the content in the four learning-centered orientations presented in this study: helping students develop expertise, preventing misunderstandings, negotiating understanding, and encouraging knowledge creation. I asked the participants if they thought the instructor controlled the content and their responses are noted in Table 4.7.
Table 4.7

Responses to Question Related to Control of Content

<table>
<thead>
<tr>
<th>Question: Do you think the instructor can control the subject or do anything differently or better? Please elaborate.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Respondent:</strong></td>
</tr>
<tr>
<td>Instructor</td>
</tr>
<tr>
<td>Student A</td>
</tr>
<tr>
<td>Student B</td>
</tr>
</tbody>
</table>

There were no similarities in these responses, so to assess the instructor’s control of the content, we (the instructor and I) engaged in a more in-depth conversation. The sequence of figures 4.5 and 4.6 represents our dialogue about content. Figure 4.5 shows our discussion about content knowledge. I began by asking the instructor to describe the value of his knowledge of geometry.

**When teaching these online Geometry courses, how valuable do you find your knowledge of Geometry?**

Geometry is my favorite subject. I can say that I have a strong content knowledge in geometry. I think it is valuable for any class. For instance group problems, van Hiele levels activity, and spatial ability activity. To include these activities someone needs to know what’s going on in geometry. These are good questions!

**Is a strong knowledge of Geometry necessary to teach this course?**

What is important to 'know' and 'why' do you think so?

**How does that 'knowing' impact your teaching and why?**

After the design of the course, the instructor should have a content knowledge above average. Every instructor knows the subject but sometimes knowledge gets rusty. If the instructor is teaching this online class, he/she should activate the knowledge, refresh the memory.

*Figure 4.5 Instructor’s knowledge of geometry (Course artifact, 06/22/07).*

The Instructor expressed his level of content knowledge and the content knowledge he thinks instructors should have. He also spoke of the course activities. I compared the course syllabus from the same course taught by this instructor in Fall 2005 and noted there were no changes to the sequence of activities. Because both courses were very similar I questioned how influential this instructor was in the sequence of course topics and activities. Figure 4.6 details
the conversation about the course activities.

**Figure 4.6** Conversation about sequence of course topics (Interview, 07/27/2007).

Earlier in this chapter I described that the instructor felt that his teaching style was based on motivation, curiosity, and promotion of learning. These points resurfaced when we began discussing content knowledge. The instructor discussed his views about his own strong content knowledge but I did not notice where the instructor exhibited the depth of his knowledge of geometry. These observations lead me to believe the instructor was constrained in this online course. I asked about any potential constraints the instructor may have felt in this online environment, and he responded, “in terms of constraints, yes it does constrain me in the sense that I cannot assess the students in the class to determine if they are more equipped with problem solving dimension of geometry or not” (Interview, 07/27/2007). It is interesting that the instructor spoke about the difficulty in assessment and Student A also discussed his worry about the lack of assessment. Student A said, “… I am not at all assured that what I submitted is right, fairly right, sort of right, or way off. Since I have just a little experience in geometry, I might not recognize being wrong” (Interview, 07/30/2007). Though the instructor had concerns about assessment, he did feel that he was able to exhibit the view that mathematical skills, understanding and problem solving were all important goals of mathematics instruction. He thought that these attributes were evident in the group problems required of students. He also stated that “one can think that he/she knows the subject but cannot solve the problem or cannot solve the same problem different way” (Interview, 07/27/2007).
Based on this analysis the instructor does control the content of the course in each of the learning-centered orientations. The instructor dictates (with approval and assistance from a panel of colleagues at the university) the content, the organization of that content, and the assignments of the course. These data support the framework presented by Samuelowicz and Bain (2001).

Model of the Knowledge Component: Modified Version

This section details the data in reference to knowledge. Recall that the framework was divided into three segments, with this section addressing the segments related to knowledge. Based on the data analysis I modified the framework, which is presented in Table 4.8. It details the findings on this Seminar in Teaching Geometry online mathematics education course.

Table 4.8
Knowledge Component for this Online Mathematics Education Course

<table>
<thead>
<tr>
<th>Belief Dimensions</th>
<th>Learning – Centered Orientations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Responsibility for organizing or constructing knowledge</td>
<td>Helping Students Develop Expertise Preventing Misunderstandings Negotiating Understanding Encouraging Knowledge Creation</td>
</tr>
<tr>
<td>Instructor</td>
<td>Learner</td>
</tr>
<tr>
<td>Nature of knowledge</td>
<td>Constructed by Learner</td>
</tr>
<tr>
<td>Students’ Existing Conceptions</td>
<td>Used by the Instructor as a basis for Conceptual Change</td>
</tr>
<tr>
<td>Control of Content</td>
<td>Instructor</td>
</tr>
</tbody>
</table>

The changes appear in bold. Just as before, the “L” and “T” were removed and were incorporated into each of the characterizations. Because those changes did not change or impact the framework, they were not bolded. The notable modifications are in three of the four belief dimensions referenced in this section (responsibility for organizing or constructing knowledge, nature of knowledge, and students’ existing conceptions). The data revealed that both the instructor and the learner have a responsibility to organize and present opportunities for the learners to construct knowledge, thereby supporting that it is instructor responsibility is more pronounced in helping students develop expertise. The learner’s presence is more pronounced in preventing misunderstanding, negotiating understanding, and encouraging knowledge creation.

The belief dimension titled Nature of Knowledge was changed in all four learning-centered orientations. The data, the course artifacts, and observations support that knowledge in
constructed by the learner in this online course. The original framework called for knowledge to be personalized to the learner, which was recognized to a degree but construction of knowledge proved to be more appropriate. The final change was noted when I assessed a student’s prior knowledge; the framework stated that it was not taken into consideration when an instructor helped students develop expertise. This was not the case in this online course; a student’s existing conceptions were used as a basis for change. The instructor had an expectation that the students came to the class with some prior knowledge (Interview, 7/27/2007).

**Pedagogical Practices and Beliefs: Instructor-Student Interaction**

I have discussed seven of the nine belief dimensions; this section presents data in relation to the last two belief dimensions (*Teacher-Student Interactions* and *Interest/Motivation*). These characteristics were found in the other sections, but because they stand alone as belief dimensions and are significant in online courses, it was better to avoid mingling the topics in the previously discussed sections. I purposely postponed discussion related to interactions, interest, and motivation until this section. In this section, I will first discuss teacher-student interactions and then I will discuss interest and motivation. This segment of the framework is represented in Table 4.9. The table is an excerpt from the framework presented by Samuelowicz and Bain (2001).

Table 4.9

**Third Segment of the Framework: Interactions**

<table>
<thead>
<tr>
<th>Belief Dimensions</th>
<th>Learning – Centered Orientations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Teacher-Student Interactions</strong></td>
<td>Helping Students Develop Expertise</td>
</tr>
<tr>
<td></td>
<td>Two-way to negotiate meaning</td>
</tr>
<tr>
<td></td>
<td>L</td>
</tr>
<tr>
<td><strong>Interest and Motivation</strong></td>
<td>Students’</td>
</tr>
<tr>
<td></td>
<td>L</td>
</tr>
</tbody>
</table>

*L: Learning-Centered*

**Teacher-Student Interactions**

Before discussing the intersection of when the learning-centered orientation and the belief dimensions meet, I first need to discuss the term ‘Teacher’ in the belief dimension of *Teacher-Student Interactions*. Similarly, before I discuss the ‘two-way interaction used to negotiate meaning’ (as termed by Samuelowicz and Bain (2001) of this online course, I first
address the belief dimension itself. I asked the instructor if he considered himself an instructor or a facilitator, he responded,

I think I consider myself sometimes instructor and sometimes facilitator. As an instructor posting announcements and regulating the official stuff. As a facilitator, being a group member for each of the groups. (Interview, 06/22/2007)

The instructor felt at some point during the course he was an ‘instructor’ and at other points he felt he was a ‘facilitator’. The students felt that the professor was a ‘facilitator’. Not only did both students consider the instructor a facilitator, there were other similarities in their responses. Table 4.10 details their responses and the responses that are similar are identifiable because they are bolded, underlined and italicized.

Table 4.10
Side-by-Side of Student Responses

<table>
<thead>
<tr>
<th>Student A</th>
<th>Student B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A facilitator.</strong> I doubt that in this format that traditional instruction can happen. But what is that? Listening to someone drone on. I can read it just as well. I would like more direct feedback as opposed to a comment here or there. It would be nice to have some idea how I am doing. Are my assignments that I turn in up to par? It would be nice to have a chance to improve. The two classes I have taken have not graded till the end. That means I have to take what I get and hope that I have been on the right track all the way through. (Interview, 07/24/2007)</td>
<td>If I had to choose, I would choose facilitator. About the only thing that my professors have done is provide us with the syllabus (and sometimes that’s been a struggle to get) and assignments, and the rest is up to us. We rarely interact with the professors, and I sometimes wonder what they do that keeps them from being active participants in the classes in which my tuition is paying them to teach. I mean, if I am going to teach myself the material, why pay the instructors? That’s a rant, though, so I apologize. Back to the matter at hand, the instructors do little teaching and little interacting. Instead, they only provide us with the materials to explore and then a grade at the end of the semester. All the “fill” in between such as interaction is generally missing. (Interview, 07/25/2007).</td>
</tr>
</tbody>
</table>

The Instructor’s belief is that he was an instructor when he posted assignments and regulating the official business of the class, and a facilitator during group assignments. This is an interesting point because the course activities that the instructor felt characterized him as an “instructor” are the very same things that caused the students to consider him a facilitator. To
further assess the role of the instructor I observed the course group assignments. There was a
dialogue during which the instructor did not interject (Course artifacts, 05/21/07). In this
instance, the students were able to resolve this particular group problem without any interaction
from the instructor. This was an opportunity for the instructor to interject, but he opted not to. I
am not claiming that the instructor acted inappropriately. Instead, this occurrence is presented as
an observation.

The instructor did interject and interact at some points. He also received a compliment
for his attempts at being more involved than some other instructors. Student B stated this
professor generally did a good job of keeping the class updated and interacting (Interview
8/11/07). While observing the course I noted a communication exchange where the instructor
did participate (Course artifact, 05/23/07).
I observed that most (if not all) the instructor’s communications were brief and infrequent.
There was no pattern to which assignments or dialogues the instructor participated in, the only
similarities were the responses were sporadic and very brief. I asked the instructor about his
seemingly passive voice in this online course by posing the following set of questions:

1) Do you feel you get to exhibit your depth of knowledge (Geometry) during online
course? I see that your responses are sometimes brief and nudge the student to look
further or in a different direction, I don't see many opportunities for you to show your true
skill set.
2) Is this an accurate observation?
3) And is your briefness intentional. (Interview, 08/09/2007)

He responded:

I think I do. I do not prefer to explain everything. It is kind of spoon feeding. Students
need to construct the knowledge. Your observation is correct my responses are brief. I am
teaching face to face classes in my native language. I did some observations, if I do the
math (show the solutions, or do problem analysis) students change their roles from active
to passive, which is not learning. I have decided not to talk too much; just let them play
with the ideas. In face to face classes I prefer ill defined assignments. I do not define the
assignments very well and I do not give them rubric.

Two consequences:
1- Students need to re-define assignments (by discussing classmates (SIC), then with me)
2-They need to find different dimensions for the rubric.
If you were in a face - to - face class how differently would you handle the class room discussions?

I am very passive if the discussion is going well. (Interview, 08/17/2007)

Based on these responses and the observations of the class, I have determined that this belief dimension would be better represented as Facilitator-Student Interactions, as opposed to Teacher-Student Interactions. A document titled, “What Can I Expect from an Online Courses” also specifically states that the role of the instructor is a facilitator (Appendix G).

Now that the assessment (‘Teacher’ versus ‘Facilitator’) is complete I will evaluate the expectation when the belief dimension and the learning-centered orientations meet. Recall that the framework expected there to be two-way interaction to negotiate meaning. For reference Table 4.9 is repeated.

Table 4.9

Third Segment of the Framework: Interactions

<table>
<thead>
<tr>
<th>Belief Dimensions</th>
<th>Helping Students</th>
<th>Preventing Misunderstandings</th>
<th>Negotiating Understanding</th>
<th>Encouraging Knowledge Creation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher-Student Interactions</td>
<td>Two-way to develop expertise</td>
<td>Two-way to negotiate meaning</td>
<td>Two-way to negotiate meaning</td>
<td>Two-way to negotiate meaning</td>
</tr>
<tr>
<td>Interest and Motivation</td>
<td>Students’</td>
<td>Students’</td>
<td>Students’</td>
<td>Students’</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>L</td>
<td>L</td>
<td>L</td>
</tr>
</tbody>
</table>

L: Learning-Centered

One mechanism of interaction is to provide feedback. The instructor described one of his strengths in the online course as, “Feedback. I can give quick feedback to content questions. Not only quick but ‘stable feedback’” (Interview, 06/22/2007). The instructor described this as one of his strengths but I observed only few occurrences when the instructor provided feedback. I found it interesting that he considered feedback important and necessary but that was not evident in some of his other comments, student comments, and even artifacts from the course. For example there were seventy-eight responses in a discussion board extract, and of those seventy-eight discussions none were from the instructor. (Course artifact, 06/04/07)

To avoid presenting a possibly isolated incident, I instead took this opportunity to compare participation of two classes, both classes titled Seminar in Teaching Geometry and both
taught by the same instructor. I found it beneficial to use the same class and the same instructor to reduce or eliminate factors that could have impacted the assessment of interaction and instructor’s stated beliefs about interaction and teaching practices. The Summer 2007 course was used as the main source of data for this study. I observed two students who were enrolled in the course. Initially I proposed to use the Fall 2005 course to confirm or disconfirm certain observations and stated instructor beliefs. By the end of the course the data from the Fall 2005 course was only used as confirmation. What the instructor stated was actually what was observed. The instructor stated his beliefs and his teaching practices through email exchanges. He stated that he believed in motivation, curiosity, and the opportunity for students to construct their knowledge (Email exchange, 5/19/2007). His dissertation work also disclosed his expertise in these topics and further stated his beliefs. There were opportunities for the instructor to sway from his stated beliefs, but I did not observe that. His stated beliefs mirrored his observed beliefs. I used the assignment tab to show the instructor’s passive voice, the intentional passive voice was to allow the students to construct knowledge. Table 4.11 shows the number of times the instructor communicated in the discussion.

Table 4.11

Assignments and Number of Instructor Responses from Discussion Board (Course artifact, Summer 2007 and Fall 2005)

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Total Responses</th>
<th>Instructor Responses</th>
<th>Total Responses</th>
<th>Instructor Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assignment 1: Review the NCTM Standards for geometry: Comment on the suitability of these geometry standards to inform the overall geometry curriculum in middle and high school and the practically of the standard to guide learning by all students. Choose two other classmates entries, review and respond. (Course artifact, 05/09/2007)</td>
<td>105</td>
<td>0</td>
<td>228</td>
<td>0</td>
</tr>
<tr>
<td>Assignment 2 Work through the e-example found at the following website (<a href="http://standards.nctm.org/document/eexamples/chap6/6.3/index.htm">http://standards.nctm.org/document/eexamples/chap6/6.3/index.htm</a>). Respond to the questions in “Take Time to Reflect” box. Choose two other classmates entries, review and comment. (Course artifact, 05/21/2007)</td>
<td>82</td>
<td>0</td>
<td>250</td>
<td>0</td>
</tr>
<tr>
<td>Assignment 3 Work through the e-example found at the following website (<a href="http://standards.nctm.org/document/eexamples/chap6/6.3/part2.htm">http://standards.nctm.org/document/eexamples/chap6/6.3/part2.htm</a>; <a href="http://standards.nctm.org/document/eexamples/chap7/7.3/index.htm">http://standards.nctm.org/document/eexamples/chap7/7.3/index.htm</a>). On the Group Discussion Board post responses to the questions in “Take Time to Reflect” box for each e-example. Choose two classmates, review their responses and comment (Course artifact, 05/28/2007)</td>
<td>78</td>
<td>0</td>
<td>236</td>
<td>0</td>
</tr>
</tbody>
</table>
Table 4.11 - continued

Assignments and Number of Instructor Responses from Discussion Board (Course artifact, Summer 2007 and Fall 2005)

<table>
<thead>
<tr>
<th>Assignment</th>
<th>Summer 2007</th>
<th>Fall 2005</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total Responses</td>
<td>Instructor Responses</td>
</tr>
<tr>
<td>Assignment 4</td>
<td>14</td>
<td>0</td>
</tr>
<tr>
<td>Assignment 5</td>
<td>74</td>
<td>0</td>
</tr>
<tr>
<td>What are the roles of puzzles (manipulatives, tangrams, pentominoes, etc…) on learning &amp; teaching geometry? <a href="http://nlvm.usu.en/nav/vlibrary.html">http://nlvm.usu.en/nav/vlibrary.html</a> (Please examine the geometry manipulatives). Please examine the puzzle powerpoint presentation under the course library. (Course artifact, 06/11/2007)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Recall that this segment of the framework states that the expectation of the Teacher-Student Interactions in a learning-centered environment would use two-way communication to negotiate meaning. I asked the instructor whether the interaction within this course was acceptable and he responded:

From my side student-teacher interaction is acceptable. In face to face classroom (we teach in my country) I don’t talk much. The more I talk the less students construct their knowledge. They just memorize or they start thinking the way I am thinking. Or they just fulfill the teacher expectations. I do interact with the students based on my observation in the classroom. It is kind of individualized instruction, individualized motivation. In the class (f-2-f) I talked with them outside of the classes or during the office hours etc… In online classes I talk through emails. (Interview, 7/27/2007)

Student B responded to the same question and stated:

I think that, in the end, the best form of interaction in these classes is between the students taking the classes. However, I would like to have my grades updated regularly and comments and updates on our assignments and postings would also help. (Interview, 08/11/07)

When I asked Student A if he thought the student – teacher interaction was acceptable, he responded,
Do you mean “is it proper?” or was the level exhibited in the class the right amount? Since there was no interaction, only an occasional comment from the teacher or a sparse answer to a student question, effective interaction was non-existent. (Interview, 07/30/07)

These comments indicated the type of interaction that was present in this online course was unacceptable to this one student, but the instructor concluded that the level of interaction was acceptable and intentional. The two students that I interviewed showed signs of frustration and stress about the low level of interaction with the instructor, but when I asked Student B, what activities in the course are most rewarding towards his education, he responded,

Generally the interactions with classmates and the exposure are most rewarding. Many of my classmates have great ideas about teaching, and I learn from these ideas. Also, interacting with so many other gifted educators through the assignments requiring us to post on the class discussion boards has exposed me to many great resources. (Interview, 07/25/2007).

This student found the interaction with fellow students the most rewarding activity towards his education in this online course. Both students expressed frustration at the poor level of interaction of the instructor but both found value in the level of interaction with fellow students. Just as presented in Table 4.11 the students were comfortable responding to each other. It was observed that the students in the Fall 2005 course were more talkative than the students in Summer 2007 course. The discussion thread in the Fall 2005 course averaged nearly seven responses per student entry, where the discussion thread in the Summer 2007 course averaged about three per student. (Course artifact, 08/17/2007) These responses led me to conclude that there was an expectation for two-way interaction that can be used to negotiate meaning as the framework noted, but in the context of this online course the two-way interaction was more often between the students, not so much the instructor. When considering the learning-centered orientations (helping students develop expertise, preventing misunderstandings, negotiating understanding, and encouraging knowledge creation) the data analysis support that the most effective interaction is between the learners.

**Interest and Motivation**

*Interest and Motivation* is the last belief dimension noted in this framework; it states that the students are responsible for interest and motivation in learning-centered orientations. I asked the instructor who he thought was responsible for interest and motivation in an online course,
and why, and he stated, “I think a little bit of both sides share responsibility - teacher and student” (Interview, 07/27/2007). I asked the students the same questions and their responses mirrored the thoughts of the instructor, both the student and instructor have an obligation as noted in Table 4.12.

Table 4.12

*Student Responses to Responsibility of Interest and Motivation*

<table>
<thead>
<tr>
<th>Question</th>
<th>Student A</th>
<th>Student B</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I am the only one who can motivate me, but creating interesting moments will help my motivation. (Interview, 07/30/2007)</td>
<td>At the graduate level, the student is responsible for interest and motivation. However, we are also driven by our performance, and not having updates from the professors on how we are doing generally stifles interest and motivation. (Interview, 08/11/2007)</td>
</tr>
</tbody>
</table>

The students expressed and immediately owned their role in interest and motivation in an online course, but also immediately expressed their expectation of the instructor. Student A went further in expressing his frustration and stated that “directions were limited to the point of being of little help” he further stated that “proper construction needs a proper foundation. One cannot build in thin air” (Interview, 07/30/2007). This statement has an impact across belief dimensions (*Interaction* and *Interest/Motivation*) but I presented it here to show that the lack of interaction directly impact interest and motivation.

This instance presents a cross-section association of the belief dimensions; there were other notable cross-section references. Throughout the interviews the participants (intentional or not) discussed their interest and motivation or the lack thereof in this online course. Those comments are below in Table 4.13. Though the questions varied, the common denominator in the responses was the opportunity taken to discuss *Interest and Motivation*. The questions in this table were asked during the interview process. The questions are sporadic and are not presented as the focal point of this discussion. For the point of discussing interest and motivation, I focused on the responses to these questions. The responses show these students’ emotions in regard to the interest and motivation.
### Table 4.13

**Summary of Response to Interest and Motivation**

<table>
<thead>
<tr>
<th>Participant</th>
<th>Question</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student A</td>
<td>During the course, did he exhibit that mathematical skills should be taught in relation to understanding and problem solving; i.e. does he exhibit a thought that mathematical skills, understanding and problem solving are all important goals of mathematics instruction.</td>
<td>I suppose that was what he intended. If allowing his students to struggle continuously without any help to the point that they finally just “threw in the towel” helps them learn those goals, then I guess we got that point. I love learning, exploring, challenges, and discovery. I didn’t like this class. (Interview, 07/30/2007)</td>
</tr>
<tr>
<td>Student A</td>
<td>How important is interaction in an online course?</td>
<td>Since lecturing in this type of class is never a good idea, interaction is even more imperative. I have come to the conclusion that online professors feel that no lecture means no contact. Or is it that lecture is the only way professors know how to relate to students? (Interview, 07/30/2007)</td>
</tr>
<tr>
<td>Student A</td>
<td>Do you think the instructor could have done something differently to ensure appropriate interactions, please explain?</td>
<td>Yes. Detailed instructions are an imperative with this type of class. Several in my group were clearly struggling, not with the toughness of the problem, but with lack of knowledge of where to begin. The instructor should have seen this and given structured guidance or smaller problems that would have given step building success. As it was, little progress was made, only frustration. Instead of being happy to know that one was on the right path and anxious for more, many in my group began to feel, “who cares”. (Interview, 07/30/2007)</td>
</tr>
<tr>
<td>Student B</td>
<td>Why do you feel you are limited in what you learn? Is that due to limitations of being online, the instructor, you, the students, etc?</td>
<td>If I was limited in my learning, it generally was because the instructors played a minimal role in the classes. This professor generally did a good job of keeping us updated and interacting, but many of the other professors gave us the syllabus and assignments and that was the last we heard from them. (Interview, 08/11/2007)</td>
</tr>
</tbody>
</table>

I asked the students how they have enjoyed online courses and the responses were interesting. Student B was most pleased with the structure of online courses. Though he shared some points of contention with online courses, he still enjoys the purpose and the logistics associated with online courses.

I enjoy online courses in that I can complete them at my own pace and in my own way. In this manner, I am freed of the constraints of meeting times, travel, and the like. I also like the establishment of a community of learners through the online environment. Times are changing and we are using the web to communicate and collaborate, and I really feel as if online courses are allowing us to establish an experience in which we can really learn from each other without many of the restraints of the physical environment such as distance. I dislike online courses in that I generally feel as if I am teaching myself the material. The professor/student interaction lacks greatly in the online environment. I will discuss this more in later questions. (Interview, 07/25/2007)  

The same holds true for Student A, who responded, “I have enjoyed the freedom to work from
home as well as having a somewhat flexible assignment scheduled” (Interview, 07/24/2007).

The students immediately (in most cases) expressed their dissatisfaction with this course, so I wanted to determine if they felt they actually learned anything. Student A said, he always learns, not matter what. (Interview, 07/24/2007) and Student B said he feels that he is learning, but he feels limited in how much he is learning (Interview, 07/25/2007). Since both students felt they were able to learn and use the knowledge in their professions, I asked what activities were most challenging. Student B responded, “The assignments that have challenged me are the ones with which I have little experience exploring the van Hiele levels or my research proposal for another class have been challenging. Once I get on board, however, I have little difficulty after that” (Interview, 07/25/2007). Notice the frustration in the same question posed to Student A, “the only challenge I have had is trying to figure out what the teacher wants. Most of the communication is not clear, have little guidance, and is given too late for me to do the job I want to do, or changed after I have spent time on the project. Frustration!” (Interview (07/24/07).

**Model of Interaction and Motivation Component: Modified Version**

With regard to this online course, the data support that a modified version of the framework will be created to show the results of the data analysis in a tabled format. Table 4.14 represents that detail of that model, specifically addressing Facilitator-Student Interactions, and Interest and Motivation and the association of these belief dimensions and the four learning-centered orientations.

Table 4.14

*Interaction and Motivation for this Online Mathematics Education Course*

<table>
<thead>
<tr>
<th>Belief Dimensions</th>
<th>Learning – Centered Orientations</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Belief Dimensions</strong></td>
<td><strong>Helping Students Develop Expertise</strong></td>
</tr>
<tr>
<td><strong>Facilitator-Student Interactions</strong></td>
<td>Two-way interaction to promote knowledge construction (Student to Student)</td>
</tr>
<tr>
<td><strong>Interest and Motivation</strong></td>
<td><strong>Facilitator</strong> and Learner</td>
</tr>
</tbody>
</table>

The first notable change was in the title, ‘Teacher’ versus ‘Facilitator’. The data support that in this online course the instructor was more considered a facilitator, which resulted in a change to the original representation. Once the heading was modified, I then evaluated the expectation associated with this belief dimension. The interactions most evident in this course took place
between students. The interaction with the instructor was sparse and very brief. This was the instructor’s intention; he wanted to give the students an opportunity to construct knowledge. Though the instructor’s lack of interaction was intentional, it was not very well received by the students, which then impacted the interest and motivation within the course.

The instructor and the students agreed that both the instructor and the students had a responsibility for interest and motivation. The instructor’s (represented as Facilitator in Table 4.15) responsibility is most evident in the learning-centered orientation of helping students develop expertise. When helping students develop expertise the initiation of interest and motivation lies with the instructor, but when learning-centered orientation relate to knowledge the responsibility is transferred to the students. This is similar to the framework presented by Samuelowicz and Bain (2001); I only modified the terminology (Facilitator to replace Teacher).
CHAPTER 5: CONCLUSIONS

The study was designed to disclose the model that would be produced when examining an online mathematics education course using a framework focused on instructor belief dimensions and learning-centered orientations. To detail the components of that model I will also address two secondary research questions, 1) What are the learning-centered orientations of the instructor’s online teaching practices and 2) How do instructor’s belief dimensions influence his on-line teaching practices? To answer the research questions I will present the model that emerged from the data analysis of an online mathematics education course titled Seminar in Teaching Geometry. In this chapter I will answer each of the research questions by using each question as a section heading. I will also discuss the implications of this study and its results for teacher educators, online professors, and education administrators clarify the goals and learning opportunities of online education in mathematics education courses.

The Model

This section will address the primary research question: What model would be produced when examining an online mathematics education course using a framework focused on instructor belief dimensions and learning-centered orientations? This study accounted for teaching practices and classroom experiences and compared them to an existing framework which allowed for assessment of an instructor’s beliefs and the expected pedagogical practices. Although the focus of this inquiry is on a particular instructor, this research is broader and has the potential to contribute to the understanding of mathematics teacher development. Recall the data were analyzed by using a framework presented by Samuelowicz and Bain (2001). This framework was not situated in an online environment; it was more of a generalization of teaching and learning-centered orientations defined in terms of belief dimensions. By using this framework as the instrument for interpretation it allowed the opportunity for me to create a model based on the findings from this study.

In Chapter 4 I divided the framework into similar categories to allow for interpretation. In this chapter those segments are combined to produce a model (Table 5.1) that considered the nine belief dimensions across the four learning-centered orientations in an online mathematics education course.
<table>
<thead>
<tr>
<th>Belief Dimensions</th>
<th>Learning – Centered Orientations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Helping Students Develop Expertise</td>
</tr>
<tr>
<td>Desired learning outcomes</td>
<td>Change in ways of thinking (Learner)</td>
</tr>
<tr>
<td>Expected use of knowledge</td>
<td>Interpretation of reality for Learners</td>
</tr>
<tr>
<td>Professional Development</td>
<td>Frustrated Learners</td>
</tr>
<tr>
<td>Responsibility for organizing or constructing knowledge</td>
<td>Instructor</td>
</tr>
<tr>
<td>Nature of knowledge</td>
<td>Constructed by Learner</td>
</tr>
<tr>
<td>Students’ Existing Conceptions</td>
<td>Used by the Instructor as a basis for conceptual change</td>
</tr>
<tr>
<td>Control of Content</td>
<td>Instructor</td>
</tr>
<tr>
<td>Facilitator-Student Interactions</td>
<td>Two-way interaction to negotiate meaning (Student to Student)</td>
</tr>
<tr>
<td>Interest and Motivation</td>
<td>Facilitator and Students</td>
</tr>
</tbody>
</table>
Learning-Centered Orientations

It is not sufficient to simply show the model without explaining the characteristics of that model. In this section I will answer one of the secondary research questions, *What are the learning-centered orientations of the instructor’s online teaching practices?* I will answer this question by presenting each of the learning-centered orientations and explaining their presence and the necessity of that presence in this online mathematics education course. Table 5.1 is a representation of the model that emerged based on the data and the findings from this study. The learning-centered orientations are *Helping Students Develop Expertise, Preventing Misunderstandings, Negotiating Understanding,* and *Encouraging Knowledge Construction.* In this section I will discuss these orientations. Because of the nature of the study there will be some reference to the belief dimensions, a more detail conclusion of the belief dimension will be discussed later in this chapter.

Table 5.2 compares the learning-centered orientations presented by Samuelowicz and Bain (2001) to the learning-centered orientations found to be relative in this online course. The table shows there was not modification to the learning-centered orientation as originally presented, but there were modifications when the learning-centered orientations interacted with the nine belief dimensions with evidence of the relationship highlighted elsewhere in this study. Table 5.2

*Comparison of Learning-Centered Orientations*

<table>
<thead>
<tr>
<th>Samuelowicz and Bain (2001)</th>
<th>Resulting Orientations based on this Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helping Students Develop Expertise</td>
<td>Helping Students Develop Expertise</td>
</tr>
<tr>
<td>Preventing Misunderstanding</td>
<td>Preventing Misunderstanding</td>
</tr>
<tr>
<td>Negotiating Understanding</td>
<td>Negotiating Understanding</td>
</tr>
<tr>
<td>Encouraging Knowledge Creation</td>
<td>Encouraging Knowledge Creation</td>
</tr>
</tbody>
</table>

The data support that there are similarities in these orientations and because of those similarities I will discuss the orientations that are closely related. Though these orientations have been slightly reorganized for the point of discussion and comparison, they did not follow that order in the presentation of the model. Figure 5.1 groups the similar orientations and shows the order the orientations will be discussed because of those similarities.
Helping Students Develop Expertise

Encouraging Knowledge Creation

Preventing Misunderstanding

Negotiating Understanding

Figure 5.1 The order of discussion of the learning-centered orientations.

Helping Students Develop Expertise

In this online course the instructor presented the content by way of syllabus, weekly assignment log, and posted discussion topics on the Blackboard E-Learning system. At that point the instructor was in control of the course and of the content that would be presented to the students. The instructor was responsible for organizing the course to establish the initial opportunity for learning. At the onset of the course the opportunity for student to construct knowledge was evidenced. The data supports that knowledge was constructed by the learner, so the instructor had an obligation to present opportunities for knowledge construction. The learners were stressed and discouraged by the lack of participation of the instructor. The instructor did not recognize or communicate his recognition of their stress. The instructor was expecting some prior knowledge that the students can use to solve the task, and if not the students quite often relied on each other. The students would then use this knowledge and the course activities to benefit their professional careers.

Based on the data I concluded that the instructor along with the students had a responsibility to help the students develop expertise. In this online environment the instructor was present to help students develop expertise. By the end of the course the students are expected to have more knowledge of the subject matter, thereby supporting that this learning-centered orientation is necessary and evident in this online course.

Encouraging Knowledge Creation

As represented by Figure 5.1 Encouraging Knowledge Creation is closely related to the orientation Helping Students Develop Expertise, the notable difference is related to timing. At the beginning of the course the instructor made available the course syllabus, presented assignments, and posted reading materials. These actions showed the instructor’s responsibility
for organizing the course. As the course moved passed these introductory steps the students become more responsible for encouraging their knowledge construction. The instructor’s responsibility for encouraging knowledge creation reduces to brief interjections at sporadic moments in the course. The responsibility for knowledge shifts to the student.

The students understand their responsibility and have come to understand the role of the instructor, even with that understanding the students felt that the instructor could and should have done more to encourage learning. The students referenced that lack of assessment when they submitted assignments. I observed that assignments were submitted but the students stated that they were not graded or assessed until the end of the course, often unsure if they were on the right track, or not.

**Preventing Misunderstanding**

This study found that the instructor and the students believed the instructor have a role and responsibility in preventing misunderstanding. The two students that participated in this study felt that the instructor’s presence should have been more pronounced; they felt that the instructor was practically non-existent – his occasional comments were not satisfactory. On the other hand, the instructor’s intentions were to be passive and offer occasional and brief interjections. He did not want to influence the student’s thought processes, by ‘influence’ I mean he did not want the students to think or solve the problem because the professor presented an idea. He wanted the students to think of various methods and approaches; he thought their previous experiences and networking with other students would prevent common mistakes.

Though the students did not particularly enjoy this portion of the course, the instructor’s intentions were satisfied, not only was that the case in this course, I also observed the course artifacts from a previous course taught by this instructor and those practices were evidenced in that course also. The students are held responsible for their professional development, knowledge construction, and their own interest and motivation.

Based on the data I concluded that the instructor, along with the students, has a responsibility to prevent misunderstanding. The students expressed their opposition to the instructor’s involvement, but found comfort in fellow students, which was the intention of the instructor.

**Negotiating Understanding**

While the students worked to prevent misunderstanding they are at the same time
negotiating understanding. These two orientations (Preventing Misunderstanding and Negotiating Understanding) are so related that they could have been presented and discussed at the same time. There is one difference that allowed me to keep them separate: students’ existing conceptions. Prior knowledge in the learning-centered orientation, Preventing Misunderstanding was used to prevent common mistakes. Student’s existing conceptions in relation to negotiating understanding are used as a basis for change. In this online environment the students have a strong obligation to the successful process of knowledge construction. This difference supports the use of this orientation in this online course.

**Belief Dimensions**

This section will address the final secondary research question, *How do instructor’s belief dimensions influence his on-line teaching practices.* Samuelowicz and Bain (2001) presented nine belief dimensions and the data from this study were analyzed based on these dimensions. Table 5.3 compares the nine belief dimensions to the resulting belief dimensions from this study of an online mathematics education course. There were two notable changes to the belief dimensions and those changes appear in bold; the detail supporting those changes was discussed in Chapter 4.

Table 5.3

*Comparison of Belief Dimensions*

<table>
<thead>
<tr>
<th>Samuelowicz and Bain (2001)</th>
<th>Resulting Orientations based on this Study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desired Learning Outcome</td>
<td>Desired Learning Outcome</td>
</tr>
<tr>
<td>Expected Use of Knowledge</td>
<td>Expected Use of Knowledge</td>
</tr>
<tr>
<td>Responsibility for Organizing or Transforming Knowledge</td>
<td><strong>Responsibility for Organizing or constructing knowledge</strong></td>
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<tr>
<td>Nature of Knowledge</td>
<td>Nature of Knowledge</td>
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<tr>
<td>Student Existing Conceptions</td>
<td>Student Existing Conceptions</td>
</tr>
<tr>
<td>Teacher-Students Interactions</td>
<td>Facilitator-Students Interactions</td>
</tr>
<tr>
<td>Control of Content</td>
<td>Control of Content</td>
</tr>
<tr>
<td>Professional Development</td>
<td>Professional Development</td>
</tr>
<tr>
<td>Interest and Motivation</td>
<td>Interest and Motivation</td>
</tr>
</tbody>
</table>

During the interviews when I asked the instructor what were his belief about teaching, the instructor responded,
I believe that teaching is not a unitary construct. It has too many dimensions. But the core elements of:

1- Teacher characteristics
2- Student characteristics
3- Learning materials
4- Interaction of all 3 mentioned above.

(Interview, 8/17/2007)

The instructor was not privy to the instrument that I used to interpret the data; I found it interesting that he made reference to dimensions when I asked him about his beliefs. Before answering this question in relation to belief dimensions, I first assessed how the instructor’s responses related to the nine belief dimensions. I cross-referenced his response to the nine belief dimensions and I was able to link each of his core elements to the belief dimensions. Figure 5.2 shows that cross-section reference. The presence each of his core elements has on the nine belief dimensions varies, with evidence of the relationship highlighted in this study.

<table>
<thead>
<tr>
<th>Nine Belief Dimensions</th>
<th>The Instructor’s Core Elements of His Beliefs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Desired Learning Outcomes</td>
<td>Teacher Characteristics</td>
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<tr>
<td>Expected Use of Knowledge</td>
<td>Student Characteristics</td>
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<td>Professional Development</td>
<td>Learning Materials</td>
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<td>Responsibility for Organizing or Transforming Knowledge</td>
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<td>Nature of Knowledge</td>
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<td>Students’ Existing Conceptions</td>
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<td>Control of Content</td>
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<td>Facilitator-Student Interactions</td>
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<tr>
<td>Interest and Motivation</td>
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</table>

*Figure 5.2 Cross-reference of the nine belief dimensions and the core elements of the instructor’s beliefs.*
Determining that his beliefs fit the nine belief dimensions created an opportunity to relate this instructor’s beliefs to this study, which is necessary to answer the research question. The instructor’s various belief dimensions have a strong presence in his online teaching practices. These belief dimensions were discussed in detail in Chapter 4, but to answer this question, I will present each learning dimension and detail the apparent influence that belief has on the instructor’s teaching practices.

---

**Desired learning outcomes.** The instructor expected there to be change in the ways the student thought about Geometry. The data supported that all activities and the instructor’s actions were tailored to the expectation of change. Students enter the course with knowledge and it is expected that they leave the course with more evolved knowledge.

**Expected use of knowledge.** The instructor expected the students to use this knowledge in their profession; at that point the knowledge would benefit each student in relation to their reality. The instructor passive voice gave the students an opportunity to develop various methods to solve problems, present their experiences to other students, and to construct knowledge, also leading to students relating these learning experiences to their realities.

**Professional development.** Depending on the learning-centered orientation, the professional development component of the learning experiences was either frustrated or motivated by the learner. The instructor did not speak to frustration of the learners, but the potential for frustration was implied by the instructor encouraging students to read a document titled, *What Can I Expect From an Online Course*. That document explained the role of the instructor and the students. The requirement for each student to read this gave the impression that he wanted to forewarn the students of the online environment and this online course.

The students expressed their frustration throughout the interviews. The most noted signs of frustration were evidenced in two orientations (*Helping Student Develop Expertise* and *Encouraging Knowledge Creation*). Although the students were frustrated, the instructor’s belief was that students should construct their knowledge, so he did not waiver and stood firm on his passive voice, offering brief feedback or words of encouragement. As the course progressed to negotiating understanding and preventing misunderstanding, professional development was influenced by learner.

**Responsibility for organizing or constructing knowledge.** The instructor frequently referenced construction of knowledge, though he did not label his teaching style as behaviorist or
constructivist (Interview, 05/19/2007). He did say, “I don’t feel but I know for sure they have constructed their knowledge” (Interview, 07/27/2007). His beliefs were evident in the course, he felt that the instructor should organize the potential for knowledge, but the students needed to organize and construct the knowledge. This responsibility is shared by the instructor and the students depending on the learning-centered orientation.

**Nature of knowledge.** The instructor’s belief is that learners should construct their knowledge. This was evidenced in the course and by several of the instructor’s responses and limited involvement in the course. I asked if he were in a face-to-face classroom would he be just as passive and reserved as he appears in this online course and he said yes (Interview, 8/17/2007). This instructor supported the ideas of constructivism, and it was exhibited in the interviews, observations, and course artifacts, supporting that knowledge is created by the learners in this course.

**Students’ existing conceptions.** The instructors expected the students to have some existing conceptions about geometry. The students also recognize that some prior knowledge was expected. The instructor’s teaching practices supported this notion; the instructor listed assignments and suggested readings to encourage knowledge construction. Prior knowledge was necessary in this online course.

**Control of content.** The instructor controlled the content of the course; the instructor did not control the content when the content was used for understanding and knowledge creation. As stated earlier, the instructor expected the students to construct knowledge based on the content (assignments, readings, and group exercises) that was presented. But at the onset of the course, there was content and organization of the course, and at that point the instructor and the institution were responsible for the content in this course.

**Facilitator-student interactions.** The instructor does have interactions with the students in the role of facilitator. The majority of the interactions that cultivate learning are done by student-to-student interactions. The instructor expects and supports these relationships and the students have placed a great value on the student-to-student interactions. The instructor’s techniques and classroom interactions support his belief that the role of the instructor is a facilitator in an online course.

**Interest and motivation.** The instructor felt that both the instructor and the student have a responsibility to motivate and make the course of interest to students. Student B appreciated this
professor attempt at interacting (Interview 8/11/07). This was one of very few positive comments about the online experience. Just to assess the instructor and the influence his belief dimension has on his teaching practices, I concluded that both the students and the instructor are responsible for interest and motivation, which is supported by the instructor’s actions, interviews and by the students.

**Themes and Implications**

This study was designed to determine the belief dimensions and learning-centered orientations evidenced in an online mathematics education course. While analyzing the data, themes emerged. Thematic analysis is defined by the identification of patterns that become evident during data analysis (Aronson, 1994). The themes that emerged from the triangulation of the data relevant to the belief dimensions and the learning-centered orientations and specific to this online course experience are:

1. As the learners support their professional development they are stressed because of their hope and expectation for the instructor to be more involved. Though stressed the learners accepted their responsibility in supporting their professional development.

2. In this online course the original belief dimensions (presented by Samuelowicz and Bain (2001) should be titled Responsibility for organizing or constructing knowledge and that responsibility is shared between the instructor and the students.

3. Knowledge is constructed by the learners in this online course.

4. Student’s existing conceptions are used by the instructor for conceptual change and the learner for conceptual change and to prevent common mistakes.

5. The instructor should be termed ‘facilitator’. Facilitator-Student interactions are brief and sporadic. Student-Student interactions are more influential in this online course.

6. The facilitator has a minimal role in interest and motivation; the students are responsible for maintaining their interest and motivation in this course.

I determined that these themes were significant because they were triangulated and evidenced by interviews, observations and/or course artifacts. By my observation and data analysis I have determined that these themes are appropriate for this online course.

When considering the professional development students are stressed by the lack of
instructor participation. Students expressed their frustration with the lack of feedback, assessment, and interaction of their instructors. The data do not support that the students expected the instructor to participate extensively; the students expected to assume most of the responsibility for professional development regarding knowledge construction. However these students would have appreciated more involvement on the part of the instructor. Though the students were frustrated by the instructor’s passive voice, the students were able to create knowledge and use it in their teaching experiences.

The implication associated with professional development is that the instructor has a presence in each of the learning-centered orientations. To accomplish this presence I propose that this online instructor determine the needs of the students and give those necessities a priority in the course activities. The students wanted to take specific experiences back to their classrooms, and that was difficult because the course was more focused on the theoretical aspects of geometry. The instructor could have incorporated more practical theories for students to analyze and research; these real-world experiences would provide an association to the student’s professional development.

I did not observe that these students expected step-by-step guidance; they would have benefited more from dialogue with the instructor. The instructor explained his passive voice by stating that he wants the students to construct knowledge, but that extreme passiveness gave the illusion of a non-existent instructor. The instructor would have to find a spectrum of passive but existent and participating without instruction to minimize the stress. It would have been beneficial for the instructor to make detailed comments as the students progressed through the course. The detail would not have to focus on the correctness or wrongness of the responses, but could have further engaged the learners in an active learning process (one that included the instructor as well as the student).

While observing this course, the students, and the instructor, I observed characteristics that support constructivism. Though this online course supports constructivist principles, not all students were so accepting. This study analyzed only two students and each of those students were frustrated by the lack of interaction from the instructor, but one student seemed more accepting to constructivism than the other.

The implication associated with constructivism is that online courses are typically developed through a learner-centered model (a major component of constructivism); therefore
supporting that constructivism is the most recognized learning theory in online courses (Beaudoin, 1999). Learning in this online course means that knowledge and meaning are actively constructed within that environment, the online environment enhances the knowledge and understanding, and the instructor and the students are supposed to ensure that the learning needs of the students are being satisfied (Rovia, 2003). The students were most frustrated with the instructor’s lack of involvement in their learning process. To address this I would suggest that the instructor incorporate more opportunities to facilitate construction of student knowledge. Jonessen (1999) offered constructivist strategies to support the instructor in this endeavor for both asynchronous (coursework not occurring at a predetermined time) and synchronous learning (coursework is at predetermined times). This course is considered asynchronous and the associated strategy would be to engage in emails with students to address and analyze their understanding of the content. The students then could feel that the instructor is involved and concerned about their learning.

The students and the instructor also spoke of the limited interaction and the lack of interest and motivation. The data supports that the most beneficial interaction is that among the students. The instructor’s interactions were so sporadic and brief that they really did not impact the learning experience (Interview, 07/24/07). The students were frustrated by this, but adapted to the need by relying on each other for clarification and assistance. The students realized their role to assist each other. If a student posted a question, without hesitation another student would answer or offer suggestions or assistance. The students did not assume the instructor would respond, nor did they wait.

The implication of the interaction is that the most effective interaction is among the students in this course. Though this was the intent of the instructor, the instructor’s participation could have been more evident or he may have disclosed that he was not participating at all. If the instructor states that he is not going to participate in the course dialogue, his occasional interjections will be a welcomed surprise. This statement does not mean that I support that the instructor’s non-participation. I support the view of Pudichery (2003) who stated that instructor interactions in an online environment enable students to construct meaningful and worthwhile knowledge. These interactions should be facilitator-learner and learner-learner; even with these interactions the learner still is responsible for constructing knowledge, self-direction and collaboration. The facilitator would be more interactive by making an effort to do so. The
instructor must manage his time (personal and professional) to create and maintain opportunities
for the instructor to be interactive. The facilitator and the students are responsible for their time
management, and therefore must make an effort to be attentive to their responsibilities in an
online course.

I observed an online mathematics education course, the instructor and two of the students
to disclose a model that identified teacher beliefs and learning-centered orientations. The model
was addressed and along with presenting the model I also explained the characteristics as a
modified model. There are strengths of this study and those strengths were evidenced earlier in
the literature review, methodology, and the presentation of the findings. The components of the
model were triangulated by data collected over a semester long online mathematics education
course. When necessary I also used a previous Seminar in Teaching Geometry course taught by
the same instructor to confirm instructor pedagogical practices. This study explained how
specific belief dimensions and learning-centered orientations were situated in this online
mathematics education course.

Even though the model and the characteristics were explained and presented to the best of
my ability, there are still some weaknesses associated with this study:

1) This study is representative of one instructor and his pedagogical practices in an online
mathematics education course. This instructor’s views are not representative of all online
instructors.

2) This study also considered the thoughts and opinions of two students; those two
students were not representative of the entire class or representative of the student
population.

3) The content of this course was approved by a panel within this department; other
online courses may follow a different process and the activities may also be different.

4) The interviews were collected through email; this method of interviewing was difficult.
It sometimes took weeks to get responses from the instructor. These delays made the
interview process choppy and clumsy.

This study has limited opportunity for generalizability to the population of online
learners, educators, and educational institutions. Because of the limitations, it was the intention
of this study to present valid and reliable data and depict thick descriptions to give the
opportunities to relate this study to the readers’ realities.
From this research ideas for future study emerged and they include:

1. This study focused on the learning-centered orientations of an online mathematics education course; a future study could examine this course to determine the existing teaching-centered orientations related to assessment (for example) in this online course. Literature supports that online courses are learner-centered (Beaudoin 1990; Oliver and McLoughlin, 1999), but is there any evidence of teaching-centered orientations related to assessment? Using the teaching-centered orientations presented by Samuelowicz and Bain (2001) to assess specific teaching-centered orientations (assessment, for example) could possibly disclose the role of assessment in online courses. I used assessment as an example because the students specifically spoke to the lack of assessment and their related frustration.

2. This study focused on the instructor and then two students; a future study could include select students and examine those student’s opinions on the learning-centered orientations. I use the term select students because the students used in this study were the only students to volunteer to participate. It would be interesting to purposely select two students: one who supports the structure of online courses (the supporter) and one who does not (non-supporter). Would the supporter’s responses produce the same results? Would the supporter’s professional development be a stressful process? What are the differences of the supporter and the non-supporters learning experiences in an online course.

3. This study produced a model for this online mathematics education course; a future study could use this model and validate or disconfirm the findings in another online course. This model was produced based on the data from this instructor, two students that volunteered, and the online course: Seminar in Teaching Geometry. Would this model be modified if any of these components change? If the model were to change if a different instructor were used, does this mean the model is appropriate for this type of instructor? If so, what type of instructor was this one? The same reasoning could follow for each component, leaving more opportunities for emerging studies.

**Summary**

The model presented identifies belief dimensions and learning-centered orientations associated with this online mathematics education course. This model will help educators,
institutional administration, and students understand the dynamics of an online environment, in hopes of enhancing the experiences for the students and the instructors. To promote online learning environments there may need to be a change in the pedagogical thinking of the online instructors. Not only should educators and administrators pay attention to the beliefs and learning orientations of the students, but also of the instructors. Instructors may intend to promote meaningful opportunities for knowledge construction in an online environment, but may lack knowledge and skill to do so. Instructors must understand the spectrum of providing the opportunity for knowledge construction at one end and the non-existent instructor at the other.
APPENDIX A

APPROVAL OF THE HUMAN SUBJECTS COMMITTEE

Office of the Vice President For Research
Human Subjects Committee
Tallahassee, Florida 32306-2742
(850) 644-6873 · FAX (850) 644-4382

APPROVAL MEMORANDUM (for change in research protocol)

Date: 4/17/2007

To: Amy Lynn

Tallahassee, FL

Dept: MIDDLE AND SECONDARY EDUCATION

From: Thomas L. Jacobson, Chair

Re: Use of Human subjects in Research

Project entitled: The Nature of Instructional Decisions that are Influenced by Constructivist Principles Which Inform Pedagogical Practices in an Online Mathematics Education Course

The memorandum that you submitted to this office in regard to the requested change in your research protocol for the above-referenced project have been reviewed and approved. Thank you for informing the Committee of this change.

A reminder that if the project has not been completed by 2/23/2008, you must request renewed approval for continuation of the project.

By copy of this memorandum, the chairman of your department and/or your major professor is reminded that he/she is responsible for being informed concerning research projects involving human subjects in the department, and should review protocols of such investigations as often as needed to insure that the project is being conducted in compliance with our institution and with DHHS regulations.

This institution has an Assurance on file with the Office for Protection from Research Risks. The Assurance Number is IRB00000546.

cc: Leslie Aspinwall

APPLICATION NO. 2007.134
Dear ____________________

I am a graduate student under the direction of Dr. Leslie Aspinwall in the College of Education, Middle and Secondary Education at Florida State University. I am conducting a research study titled "The Nature of Instructed Decision Making that are Influenced by Constructivist Principles Which Inform Pedagogical Practices in an Online Mathematics Education Course." The purpose of this study is to address the instructional experience in an online mathematics education; by that I would like to analyze the communication and interaction patterns, identify the way that web-based classroom encourages online discussion; discover methods of fostering constructivist principles, and to analyze the instructor's role in a web-based classroom.

Your participation will involve interviews and observation of your commentary within online mathematics education courses, and the download of documents from the courses. The data gathering phase should last no more than a year.

Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty. The results of the research study may be published, but your name will not be used.

There are no foreseeable risks or discomforts if you agree to participate in this study.

Although there may be no direct benefit to you, the possible benefit of your participation is the results of this research can be used to inform the readers, serve as an addition to existing research, and generate an opportunity for future research.

If you have any questions concerning this research study, please call me (850-210-4273 or email acl_consulting@yahoo.com) or call Dr. Aspinwall at 850-644-6523.

Sincerely,

Apryl C. Lynn

* * * * *

I give my consent to participate in the above study.

______________________________   ________________________________
(signature)                       (date)

If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk, you can contact the Chair of the Human Subjects Committee, Institutional Review Board, through the Vice President for the Office of Research at (850) 644-8633.
APPENDIX B - continued

PARTICIPANT CONSENT

Dear ____________________ ,

I am a graduate student under the direction of Dr. Leslie Aspir-wall in the College of Education, Middle and Secondary Education at Florida State University. I am conducting a research study titled The Nature of Instructional Decisions that are Influenced by Constructivist Principles Which Inform Pedagogical Practices in an Online Mathematics Education Course. The purpose of this study is to address the instructional experience in an online mathematics education; by that I would like to analyze the communication and interaction patterns, identify the way that web-based classroom encourages online discussion; discover methods of fostering constructivist principles, and to analyze the instructor's role in a web-based classroom.

Your participation will involve interviews, observation within two online mathematics education courses, and the download of documents from the courses. The data gathering process should last no more than four weeks and will include two courses: one active/current course and a course recently taught by you.

Your participation in this study is voluntary. If you choose not to participate or to withdraw from the study at any time, there will be no penalty. The results of the research may be published, but your name will not be used.

There are no foreseeable risks or discomforts if I agree to participate in this study.

Although there may be no direct benefit to you, the possible benefit of your participation is the results of this research can be used to inform the readers about in an addition to existing research, and generate an opportunity for future research.

If you have any questions concerning this research study, please call me (850-210-4273 or email aed_consulting@yahoo.com) or call Dr. Aspir-wall at 850-644-6553.

Sincerely,

April C. Lynn

I give my consent to participate in the above study.

____________________________ (signature) ______________________________ (date)

If you have any questions about your rights as a subject/participant in this research, or if you feel you have been placed at risk you can contact the Chair of the Human Subjects Committee, Institutional Review Board, through the Vice President for the Office of Research at (850) 644-6553.

FSU Human Subjects Committee Approved on 02/27/07 Void After 02/27/08 HSC # 2007-20
APPENDIX C
INSTRUCTOR INTERVIEW QUESTIONS
Semi-Structured

What are some of your desired outcome for the students in this course? Do you feel that it was achieved? If not, how/what do you think could have been done differently to help to students achieve your/their goal?

What is the basis for your pedagogical practices and how were they developed?

How would I describe my teaching style?

Do you feel that you taught them or did the students construct their own knowledge? How do you expect the students to use this knowledge?

Who do you think is responsible for organizing or transforming knowledge? And why?

Do you think the you can control the subject or do anything differently or better, please elaborate?

Do you think that you used exercises to build on the students' prior knowledge or is student's success in this class isolated from prior knowledge?

Do you feel the student – teacher interaction is acceptable? Do you think they you could have done something differently to ensure appropriate interactions, please explain? How heavily do you weigh interaction in an online course?

Please give me an example of what lesson/communication (from this course) you think is most valuable and something that the students can take to their profession, and why?

Who do you think is responsible for interest and motivation in an online course, why?

Do you feel you allowed students to construct their own mathematical (geometric) knowledge, how or how not?

Do you feel you organized instruction to facilitate construction of knowledge, how or how not?

Do you feel that you sequenced the course or topics of instruction based on the class development, please elaborate?

During the course, did you exhibit that mathematical skills should be taught in relation to understanding and problem solving; i.e. do you exhibit a thought that mathematical skills, understanding and problem solving are all important goals of mathematics instruction?

Why did you want to add more to the course (than what was originally approved by the panel)?
Is any part of your teaching style challenged / constrained in an online environment? Please elaborate.

Did you feel the more problems would make for a better learning opportunity?

Is any part of your teaching style challenged / constrained in an online environment? Please elaborate.

Can you describe your pedagogical practices in this online course?

How is that different or similar from your teaching styles that you described earlier?

What are your beliefs about teaching?

When teaching these online Geometry courses, how valuable do you find your knowledge of Geometry?

Is a strong knowledge of Geometry necessary to teach this course?

What is important to 'know' and 'why' do you think so?

How does that 'knowing' impact your teaching and why?

Do you consider yourself and instructor or facilitator of this course and explain?

Do you think your knowledge of the subject matter is a direct product of your beliefs?

Do you feel you get to exhibit your depth of knowledge (Geometry) during online course? I see that your responses are sometimes brief and nudge the student to look further or in a different direction, I don't see many opportunities for you to show your true skill set. Is this an accurate observation? And is your briefness intentional.

Did you decide (independent of the panel that put the course together) to include extra activities into the course? If so, why and what value do you think the additional assignments or modifications will add to the course?

If you were in a face - to - face class how differently would you handle the classroom discussions?
APPENDIX D
STUDENT INTERVIEW QUESTIONS

How do you enjoy online courses?

What activities in the course are most rewarding towards your education?

Have any of the assignments challenged you? Which one and in which way?

What was your desired outcome for this course? Was it achieved? If not, how/what do you think could have been done differently to help you achieve your goal?

Do you feel the instructor taught you or did you construct your own knowledge? How do you expect to use this knowledge?

Who do you think is responsible for organizing or transforming knowledge? And why?

Do you think the instructor can control the subject or do anything differently or better, please elaborate?

Do you think the instructor used exercises to build on your prior knowledge or is your success in this class isolated from prior knowledge?

Do you feel the student – teacher interaction is acceptable?

Do you think the instructor could have done something differently to ensure appropriate interactions, please explain?

How heavily do you weigh interaction in an online course?

Please give me an example of what lesson/communication (from this course) would you take to your profession, and why?

Who do you think is responsible for interest and motivation in an online course, why?

Do you feel he allows you to construct your own mathematical (geometric) knowledge, how or how not?

Do you feel he organized instruction to facilitate construction of knowledge, how or how not?

Do you feel that he sequenced the course or topics of instruction based on the class development, please elaborate?
During the course, did he exhibit that mathematical skills should be taught in relation to understanding and problem solving; i.e. does he exhibit a thought that mathematical skills, understanding and problem solving are all important goals of mathematics instruction.

Do you really feel like you are learning anything?

Would you consider the instructor an instructor or a facilitator, and why?
Course Syllabus

MAE 5338
Seminar on Teaching Geometry

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<th>Instructor Information</th>
<th>Professor</th>
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<td>Office Hours</td>
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| Course                      | This course will examine current literature on learning and teaching geometry. Through class activities and assignments curriculum aligned with state and national standards will be explored. Activities will provide the opportunity to develop knowledge of appropriate manipulatives to use in the development of geometric concepts. Focus will be primarily on topics appropriate for 6-12 mathematics classes, with some extensions into post-secondary applications. |

| Required Materials            | • Navigating through Geometry in Grades 6–8 By David K. Pugalee, Jeffrey Frykholm, Art Johnson, Hannah Slovin, Carol Malloy, and Ron Preston  
• Navigating through Geometry in Grades 9–12 By Roger Day, Paul Kelley, Libby Krussel, Johnny W. Lott, and James Hirstein  
Both of these books can be purchased on-line at the NCTM website. Go to this site and you can find both publications: http://nctm.org/standards/navigations.htm |

| Course Objectives             | This is a seminar and as such will be structured as a forum to explore and discuss the teaching and learning of geometry for today's students. All students are expected to participate in course discussions and |

| Topical Course Outline        | Topics will be chosen from this list. Topics chosen will be selected based on the current issues in teaching geometry, the perceived needs of students as determined by the instructor and students.  
Geometric Art  
Introducing Geometry  
Line and Angle Properties  
Polygon Properties  
Transformations and Tessellations  
Pythagorean Theorem  
Similarity  
Deductive Reasoning  
Sequences of Proofs  
Inductive Reasoning  
Using Tools of Geometry  
Triangle Properties  
Circles  
Area  
Volume  
Trigonometry  
Geometric Proof |
### Teaching Strategies

The participants and professor will create a learning community for sharing of reflections on readings and presentations and discussion of perspectives on curriculum relevant to mathematics.

The emphasis will be on sharing, support in the group environment, and personal development of meaning.

### Assessment

<table>
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<tr>
<th>Category</th>
<th>Description</th>
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<tr>
<td>Geometry Problems: 25%</td>
<td>Problems, such as geometric constructions, will be assigned for completion. Completed work will be submitted through the Digital Drop Box.</td>
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<tr>
<td>Group Discussions: 30%</td>
<td>Discussions on web activities, journal articles and other readings will be completed through the Discussion Board and/or Group Discussions.</td>
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<tr>
<td>Final Project: 30%</td>
<td>The final project will be individually determined and will allow the student to demonstrate a breadth and depth of understanding of the teaching of geometry. The assignment description may be found under Course Assignments.</td>
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<tr>
<td>Geometry Resource File: 15%</td>
<td>An electronic file that provides for a set of rich resources that may be used in the teaching of geometry. The resources should include (but are not limited to) URLs, problems, journal articles, and lesson plans.</td>
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### Participation

**Participation** is vital for knowledge construction by each student; numerous learning experiences conducted in class cannot be duplicated in any other way. In-class activities (e.g., cooperative group work, presentations) are not formatted for completion outside of class. Timely, relevant feedback is an important component of any learning environment. Full participation in all discussions, whether instructor-facilitated, student-facilitated or small group, play an integral role in the success of this course and is required.

There are many activities planned for this course, some of which require that you post a written response on the Course Web site using the Discussion Board, Virtual Chat, Student Pages or Drop Box buttons. Participation in these activities is a course requirement. At scheduled intervals, your instructor will check your portfolio and the conferences to see if all is going well.

Although the online learning activities are asynchronous and provide a degree of flexibility in terms of when and where you participate, it is critical that you adhere to the course schedule.

Full participation in all online discussion, whether instructor-facilitated, student-facilitated or small group, is required. When participating in an online discussion adhere to the following guidelines:

- Identify yourself when entering the discussion (anonymous comments and questions are not acceptable).
- Join online class discussions/activities within the designated periods.
- The instructor or facilitator should provide a schedule for participation. Interpreting and handling the parallel nature of branch/threaded discussions in conferences and email messages is difficult when you
have been “out of the loop.” Keeping up with the activity schedule is an effective way of managing information overload.

- Take time to carefully read and think about other students’ comments before responding to facilitator questions. We want to generate knowledge, not duplicate it!
- Post relevant comments, thought provoking questions, and responses to questions posed by others. One of the advantages of asynchronous communication is that you have time to think before responding, thus enhancing the quality of dialogue. Take advantage of this!
- At scheduled intervals, your instructor will check the Discussion Board conferences to monitor your participation. You will be assessed on the frequency in which you participate and the content of your contributions to the activity. Your instructor will be looking for unique contributions that reflect a thoughtful analysis of the course material.

<table>
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<th>Academic Honor Code</th>
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<td>Students are expected to uphold the Academic Honor Code published in The Florida State University Bulletin and the Student Handbook. The Academic Honor System of The Florida State University is based on the premise that each student has the responsibility to (1) uphold the highest standards of academic integrity in the student’s own work, (2) refuse to tolerate violations of academic integrity in the university community, and (3) foster a high sense of integrity and social responsibility on the part of the university community.</td>
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<th>Students with Disabilities</th>
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<td>Students with disabilities needing academic accommodations should (1) register with and provide documentation to the Student Disability Resource Center (SDLC), 850-644-9566 (voice), 850-644-8504 (ADD); (2) bring a letter to the instructor from SDLC indicating the need for the accommodation and what type. This should be done within the first week of class.</td>
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<th>Suggested Reading</th>
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All instructors have expectations from students. They want them to master the content of the course. It is unfortunate that not many students reach the level that teacher expected. Very few show performance above the teacher expectations which beyond the scope of the class (A+ STUDENTS). This performance is shown most of the time on certain topics rarely whole topics in the course. Some students fails (F students).

At the end of the course student performance

When the semester is over students’ knowledge move toward to the center
A course 12 topic and 1 student knowledge map
APPENDIX G

WHAT CAN I EXPECT FROM AN ONLINE COURSE?
(Mathematics Education Program)

We, in Math Education, make every attempt to create online courses that are exactly the same as regular face-to-face (F2F) classroom courses in quality, objectives, and learning outcomes. We strive to create an online environment where the only difference is the use of the Internet, instead of a F2F "classroom." Thus there is a different "methodology" for online teaching and learning, and these differences can’t be avoided. In this document we will attempt to highlight some of the important differences and similarities to give you an idea of what to expect in these courses.

What to expect from your professor and course mentors.

Online courses are "Student Centered" rather than "Professor Centered," so you will not sit and listen to long verbal lectures, you will not have routine homework (because all of your work is homework), and you may not be required to log into your course at any specific day and/or time unless required to do so by the professor. Your professor plays a different role from F2F. He/She will serve as a "facilitator" and will assist you in learning the material required; explain details clearly in writing; provide you with information links, requirements, web and online materials, references, etc… He/She will answer all email questions usually within 24 hours; correct all required work, papers, projects and quizzes as quickly as possible (usually in one week’s time of the assignment due dates); and post your grade in your grade book periodically.

In a F2F classroom, you would still receive the same instructions as in an online course except you would receive it verbally and not in writing. This is a key difference because student–to-professor communication can sometimes seem alienating to you online. For example, in a F2F course you can ask for clarifications on instructional materials in real time while in class or during office hours. Online you may have to wait up to 24 hours for the same clarification and expect that sometimes more than one email exchange may be required before you are satisfied and clear on how to proceed. This will require both patience and clarity in writing on your part. Be specific and as detailed as possible when asking a question via email. ALWAYS say who you are, what class you are in, and exactly why you are emailing, especially if you are new to the professor’s/mentor’s course. Your professor will do the same. Over time, you will see that you develop a comfort level in communicating with your professor/mentor that for most students are better than F2F.

Course Mentors serve as TAs for the course. They may have many of the same responsibilities as your professor. Depending on the course these may include; grading, communications with you (one-on-one and in groups), posting materials, and helping you with course content. Their primary responsibility however, will be to help you resolve non-content problems that you may encounter while online. For example: navigating the website, uploading and downloading materials and assignments, email problems, software problems. They may answer your questions directly guide to a site or location to find the answer.

The professor and course mentor are on your side and will do their best to facilitate your learning, but you, the learner, will have responsibilities also.

What to expect from you and your classmates.
You must be an "active learner", not "passive" waiting for your professor/mentor to remind you to do your work, checking on your progress everyday and telling you what you are missing each week. A successful online student will take the responsibility for his or her own learning: completing work on time; emailing the professor and/or course mentor for assistance; keeping the professor and/or course mentor informed of any personal issues and learning assistance you need; communicating with other students in the class on a regular basis (via Help forum & emails); keeping up with readings, case studies and web links; logging into the course almost daily (including weekends) for announcements, updates, and to communicate with your classmates, check your emails daily for information concerning the course; and completing the course on time.

Your participation is a key element to making this online course (and others) a successful learning experience for you. Here are some examples of what you can do make your experience as close to F2F as possible.

**Student-to-student (S2S) communication:** If you think of how you interact with other students in a F2F class (especially math) those characteristics can be reproduced online. For example, many students may meet in study groups (both in class and out of class) to discuss notes, research ideas, problems solving, clarification of concepts, etc… This can be duplicated in two ways online. First there will be some kind of “Help/FAQ Forum” on the class discussion board for each online course you take in this program. These forums can be used to capture that group study environment that you can ordinarily create F2F, because all students are local. With the differences being that it will be totally in writing and non-verbal, and the professor and mentor will be able to participate periodically. However, the purpose of the forum is for S2S communications.

**Student-to-professor/mentor communication:** When you are F2F with your professor in a classroom you may spend most of your time listening and taking notes while the professor gives verbal instructions. Online, this is reproduced by written notes and instructions provided by your professor, a textbook, and/or some other means. Instead of verbal real-time (synchronous) communication, you will receive for the most part asynchronous written communication where you will have to wait for responses.

Also, when you are F2F the professor may have many a classroom discussions where everyone can participate. This can be more effective online than F2F for many reasons: F2F, not students often to get a chance to say all that they want to say because of time constraints. In online discussions, you cannot be interrupted be the “big bad professor” before you have completed your thoughts.

Introverted personalities who don’t ordinarily participate in F2F classroom discussions find the online environment a much for friendly forum for discussions. They often participate much more online.

You will have time to think about and conduct research before you respond. Your professor’s and mentor’s role in class discussions will basically be the same. He/She will read everyone’s contributions (F2F they will listen). They will facilitate the discussion by asking
thought provoking questions or providing his/her own comments. Just as in F2F, he/she will probably NOT respond to everyone’s comments individually, but will make SOME individual comments and mostly general comments to the entire class. Think of your F2F discussions and how they occur. The professor may call on two, three students to comment before they make a comment or change the course of the discussions. He/She rarely stops after every student comment to respond individually, it would be inefficient to do so.

**What to expect in Grading.**
Expect to be graded on the value, content and timeliness of your work - not on other issues such as number of emails and questions, class dominance, past course performance. You can expect your professor/mentor to give you as much of an opportunity to improve throughout your course, but all work must be completed by the timeline on the syllabus. If ever you think you will be late posting an assignment, please email your professor and mentor ASAP to ask for an extension. Extensions are almost always granted upon request as long as it does not become habitual.

For most assignments your papers will email back to you with comments on them about a week after the due date. If you turn in an assignment late, you may not get the paper back within this time period and may have to wait longer. Grades will be posted online at about the same time. However, to save time one or both of the following may occur.

You may not get your paper emailed back to you if you have received 100% credit and your professor/mentor has no comments other than “good job” etc. If this is a problem, please email your professor to ask that a copy be emailed to you.

If your professor sees many students making the same error, he/she may choose to make general comments to the class, via the “announcements” page instead of repeating the comment on each paper. You will still get other individual comments back via email.

**More Information about Online Courses**
You will find that you learn more than you expected in these courses. By being an active learner, you will remember more of this course and feel more of an accomplishment upon completion. Expect an online course to take you more time and energy than a F2F classroom course, but the results are often that you learn more, too!

Students are often surprised to find that they feel they get to know their professor/mentor and classmates better online than in a F2F classroom, due to the number of emails and contacts, more active class discussions and interactions online during the weeks than in a formal classroom setting.

Expect that your teachers and classmates may be from any place in this state, country or from around the world! The Internet offers a wonderful opportunity to take classes with people you would not normally meet from around the country. This is great for teacher education courses because it gives you an opportunity to discuss the differences and similarities between states, and other countries.

You will learn more than the content of the course: expect to learn how to do research online,
how to utilize and experience new web sites, how to use more computer applications (which may include NetMeetings, Adobe Acrobat, file attachments, voice-streaming, PowerPoint presentations, etc), utilize new search engines and, most importantly, how to express yourself better in writing.

In F2F conversation, there are many subtle non-verbal cues provided by body language and/or vocal inflection that let us know how what we are saying is affecting the other person. These cues and inflection are totally absent in online communication. Thus you must strive to be concise, clear, and polite in your writing, and flexible and open minded in your interpretation of students’ and professors responses. Assume no ill will and always give the benefit of the doubt.

**Am I suited for Online Learning?**
Well, you will basically find out after you have completes your first online course. You will either thoroughly enjoy the convenience of making your own schedule and taking your class at home or you may really miss the structure of a "professor-centered" education in a F2F classroom setting! This is very understandable, and you may find out (or now know) what type of education will best serve you and better understand your learning style. Are you an:
"Active or Reflective Learner"
"Sensing or Intuitive Learner"
"Visual or Verbal Learner"
"Sequential or Global Learner"
(You can look these up on the web or visit this site: [http://www.engr.ncsu.edu/learningstyles/ilsweb.html](http://www.engr.ncsu.edu/learningstyles/ilsweb.html))
You will more enjoy this type of course and program if you:
Are highly motivated
Are Independent
Understand your "Learning Style"
Have good organizational skills
Put a high value on "convenience"
Can adapt to new environments easily
Enjoy searching for information on your own
Have a good working knowledge of your computer and basic computer applications
Check your email every day and can attach files and open attachments in your email program
Are Disciplined
Are not dependent on other class members and teachers to help you everyday
Are confident in your academic abilities
Have successfully taken college courses in a classroom
Consider yourself a "college-level" reader
Consider yourself a mature adult with time good management skills

**Basic Computer Requirements to be a Successful Online Student**
As a general rule, the better and more reliable the computer, the more successful you will be in an online course. We recommend a Pentium III, or IV, with Windows 98 or above; however, the minimum capabilities for success are listed below:
Pentium 166 or better
128 Megabytes of RAM; 256 is preferable
2G processor
Windows 95 or better
MS Office 97 or better
Microsoft Word® 97 or better Required!
Modem 28.8 or better (DSL or Cable is the absolute best)
Internet Connection Required!

NOTE: If your computer breaks or your Internet connectivity is disrupted in a course, it is up to you to access another computer to complete your work. You may not need to drop your course and probably won’t get a refund. Your courses are totally online, and you may enter and do your work on ANY computer that is connected to the web. In an emergency, you may use a local library, a friend's computer or an available computer at your local College or University. Please notify your course professor and mentor if this happens.

References:

http://www.coe.uh.edu/courses/cuin6373/onlineinfo/characteristics.html
http://www.coe.uh.edu/courses/cuin6373/onlineinfo/characteristics.html
http://www.vto.vt.edu/help.php?id=44&cat=Credit%20Courses
http://www.waol.org/learnToLearn/Module6/mod6_531.htm
http://www.bucks.edu/distance/dlresources/expect.html
http://online.fisher.edu/faq_3.html
http://online.elac.edu/
http://wsuonline.weber.edu/faculty/teaching/expectations.htm
http://www.mentorplace.org/ddm/MPTCCommunication.htm

REFERENCES


BIOGRAPHICAL SKETCH

Apryl Charelle Granger Lynn graduated from Florida Agricultural and Mechanical University in Tallahassee, Florida with a Bachelor of Science in Mathematical Science and a Master of Business Administration. She anticipates earning a doctoral degree in Mathematics Education in the Spring of 2008. Her research interests include mathematics education, online learning, teacher beliefs, and instructor practices.